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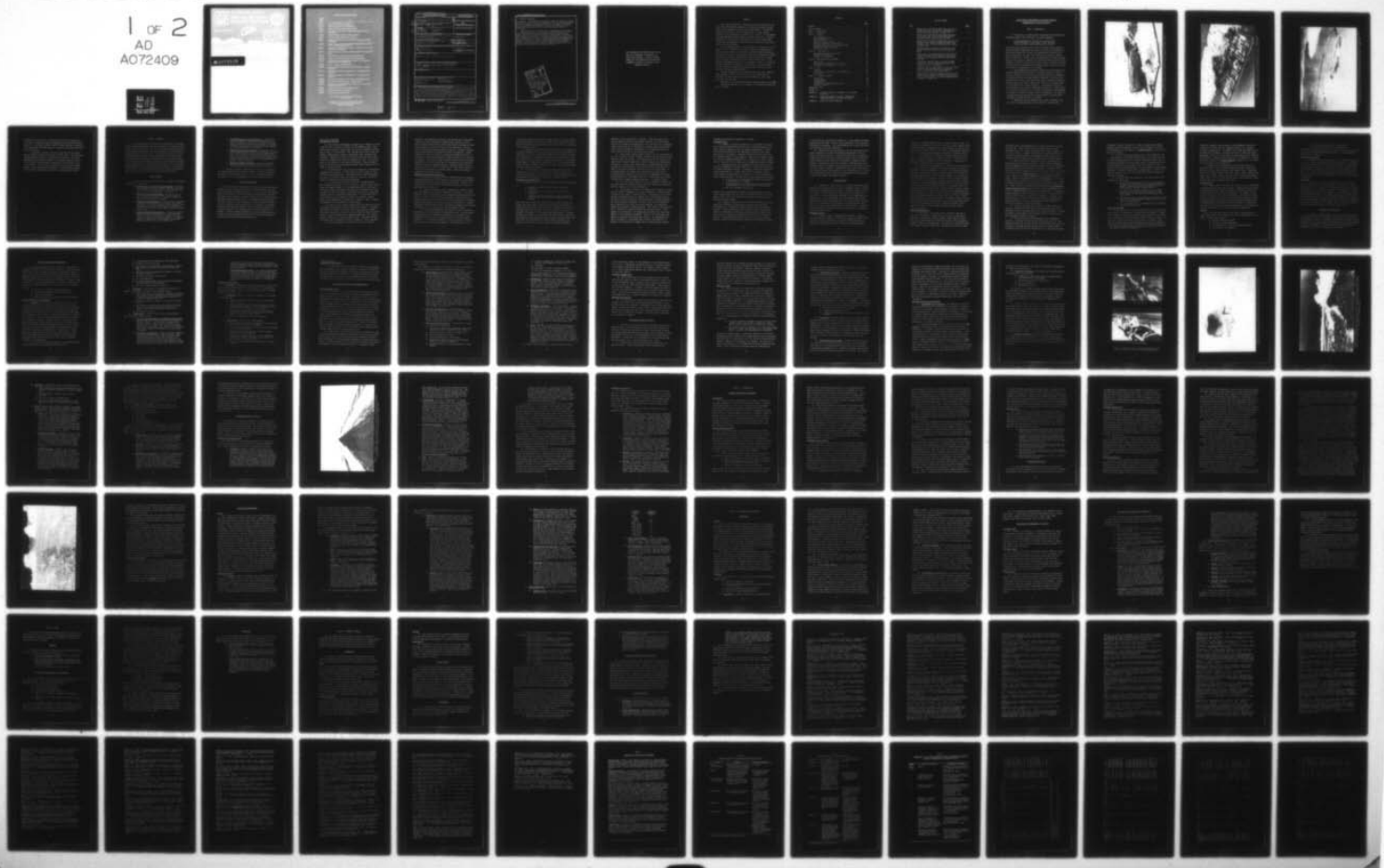

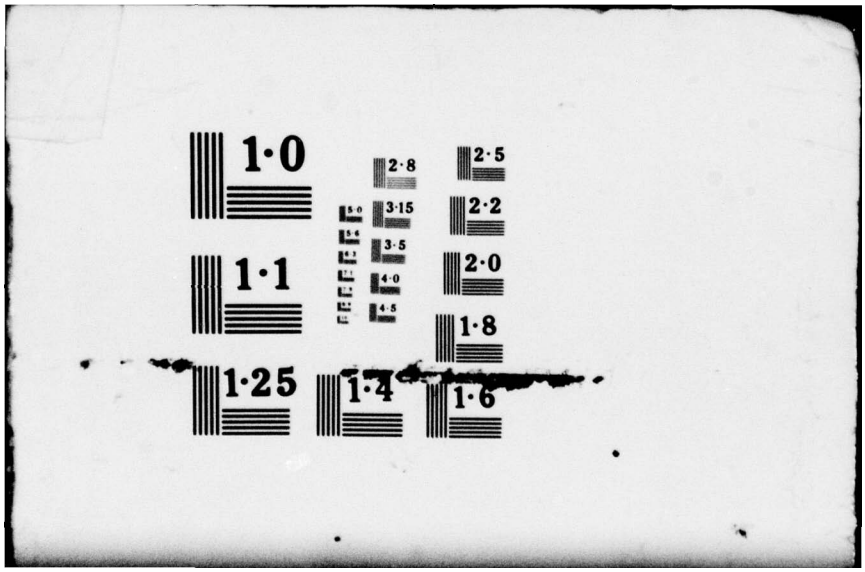
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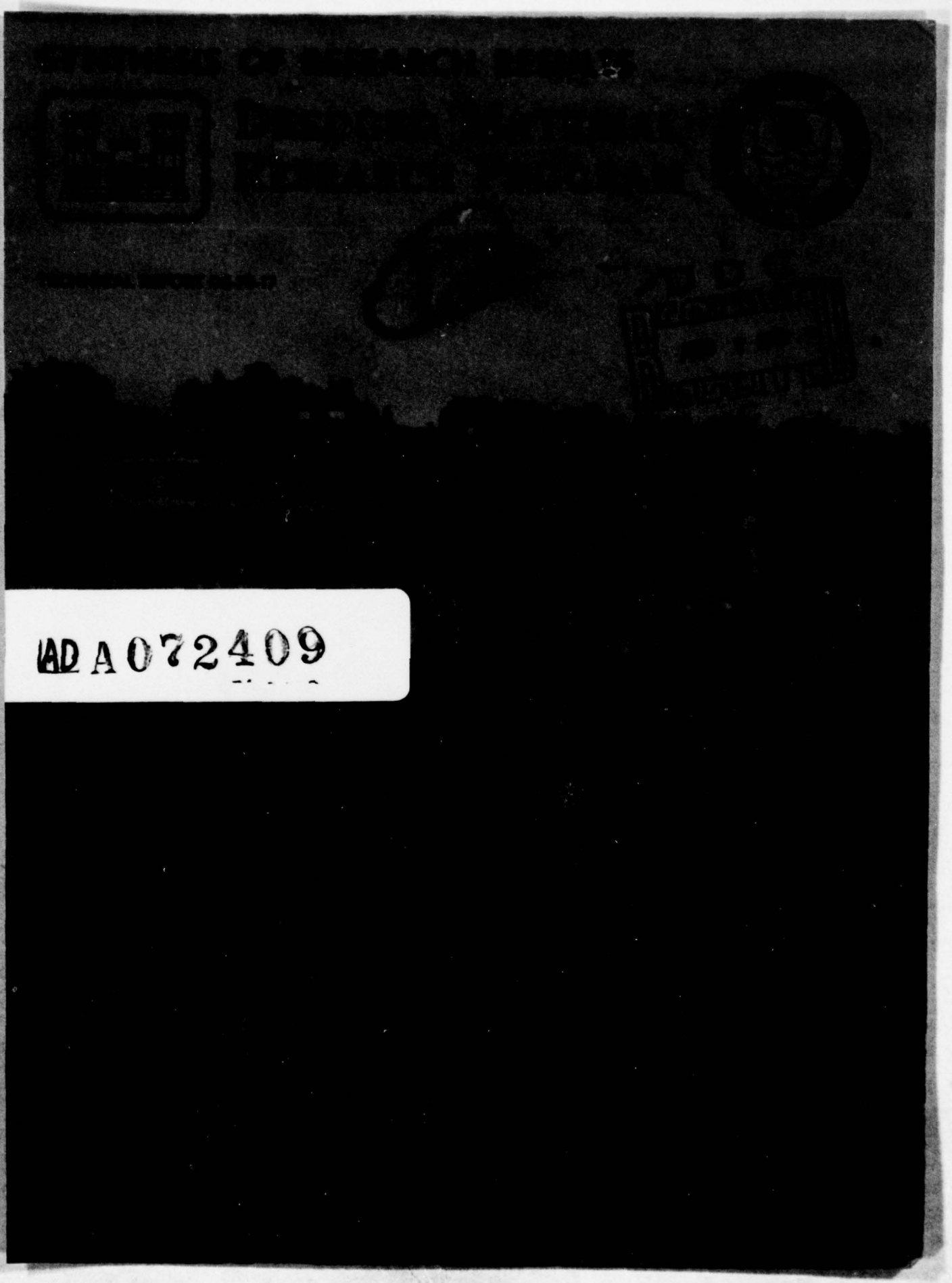

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Upland habitat development using dredged material as a substrate was shown by the Dredged Material Research Program (DMRP) to be a feasible alternative to standard dredged material disposal operations. This report synthesizes pertinent literature and research at three major DMRP upland field sites: Miller Sands in the Columbia River, Oregon; Bolivar Peninsula in Galveston Bay, Texas; and Nott Island in the Connecticut River, Connecticut. Guidelines for developing existing or potential dredged material disposal sites into upland habitat

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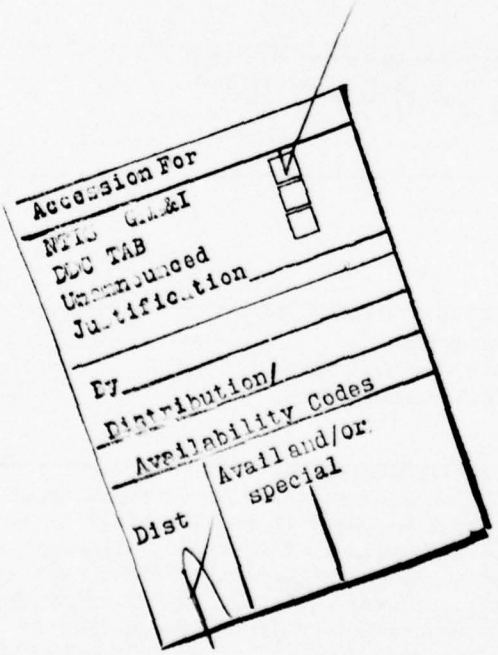
are presented: (a) planning and designing the project in relation to the proposed site and project goals; (b) construction of the site including dredging and disposal operations, substrate modification, and vegetation establishment; (c) maintenance and management of the site as a habitat; (d) costs of proposed and sample projects; and (e) potential problems that may be encountered.

Emphasis is placed on two major areas: engineering and plant propagation. Engineering aspects include data collection and analysis for site design, protective and retention structures, substrate characteristics, dredging and disposal operations, and specific requirements. The phases of plant propagation are detailed: selecting plant species; selecting, collecting, and handling plant materials; planting; maintenance and management; and costing the work effort. Tables of 360 selected plant species showing best propagules, occurrence by region and whether known to occur on dredged material, growth requirements and habits, propagule handling methods, soil tolerances, and other pertinent information are given.



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PREFACE

This report synthesizes literature and research pertinent to upland habitat development conducted by the Habitat Development Project (HDP) of the Dredged Material Research Program (DMRP). The DMRP was sponsored by the Office, Chief of Engineers, U. S. Army, and was assigned to the Environmental Laboratory (EL) of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. Research synthesized in this report was performed by personnel of WES, other Federal and state agencies, consulting firms, educational institutions, and by private individuals.

The following personnel of EL participated in preparation of this report: Ms. L. Jean Hunt and Ms. Mary C. Landin, Environmental Resources Division (ERD); Mr. Alfred W. Ford, Environmental Engineering Division; and Dr. B. R. Wells, EL and University of Arkansas Rice Experiment Station, Stuttgart. Review was provided by Ms. Mary K. Vincent and Dr. Raymond L. Montgomery, EL; Mr. Charles Newling and Mr. Fran Donovan, New England Division, CE; Dr. Kenneth O. Allen, U. S. Fish and Wildlife Service; Dr. Richard A. Cole, New Mexico State University; Dr. John Crawford, Oregon State University; and Dr. Robert J. Diaz, Virginia Institute of Marine Science.

Work was performed under the general supervision of Dr. Hanley K. Smith, Manager of HDP; Dr. Conrad J. Kirby, Jr., Chief, ERD, EL; Dr. Roger T. Saucier, Special Assistant for DMRP, EL; and Dr. John Harrison, Chief, EL, WES.

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Director of WES was COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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UPLAND HABITAT DEVELOPMENT WITH DREDGED MATERIAL: ENGINEERING AND PLANT PROPAGATION

PART I: INTRODUCTION

1. A definition of upland habitat development can be obtained by modifying Yoakum's (1971) definition of habitat management:

> To develop habitat is to bring into existence the proper conditions of food, water, cover, and space to provide better living conditions for wildlife.

As Leopold (1933) stated and more recent investigators have verified, proper conditions change with the species of wildlife and geographic region and may change with the age, sex, and physical condition of the animal and season of the year. Both quantity and quality of habitat must be considered. In most cases, the primary goal of habitat development will be to improve conditions for selected wildlife species or communities. Secondary objectives may be met as well: provision of recreation facilities and opportunities, increased aesthetic value, control of soil erosion, or improvement of soil quality.

2. The Dredged Material Research Program tested the premise that sediments dredged from the bottoms of waterways and harbors could be used as a substrate on which to develop upland habitat, thus supplying an alternative method of dredged material disposal. Field sites were located at Nott Island in the Connecticut River, Connecticut (Figure 1); Bolivar Peninsula in Galveston Bay, Texas (Figure 2); and Miller Sands in the Columbia River, Oregon (Figure 3). Activities and results of investigations at the sites are summarized in Hunt et al. (1978), Allen et al. (1978), and Clairain et al. (1978), respectively. Upland habitat is defined as an area not normally subject to inundation. An island is a specialized upland habitat that is characterized by isolation and completely surrounded by water or wetlands.

3. Experience and data obtained from habitat development field test sites on dredged material and from pertinent literature are

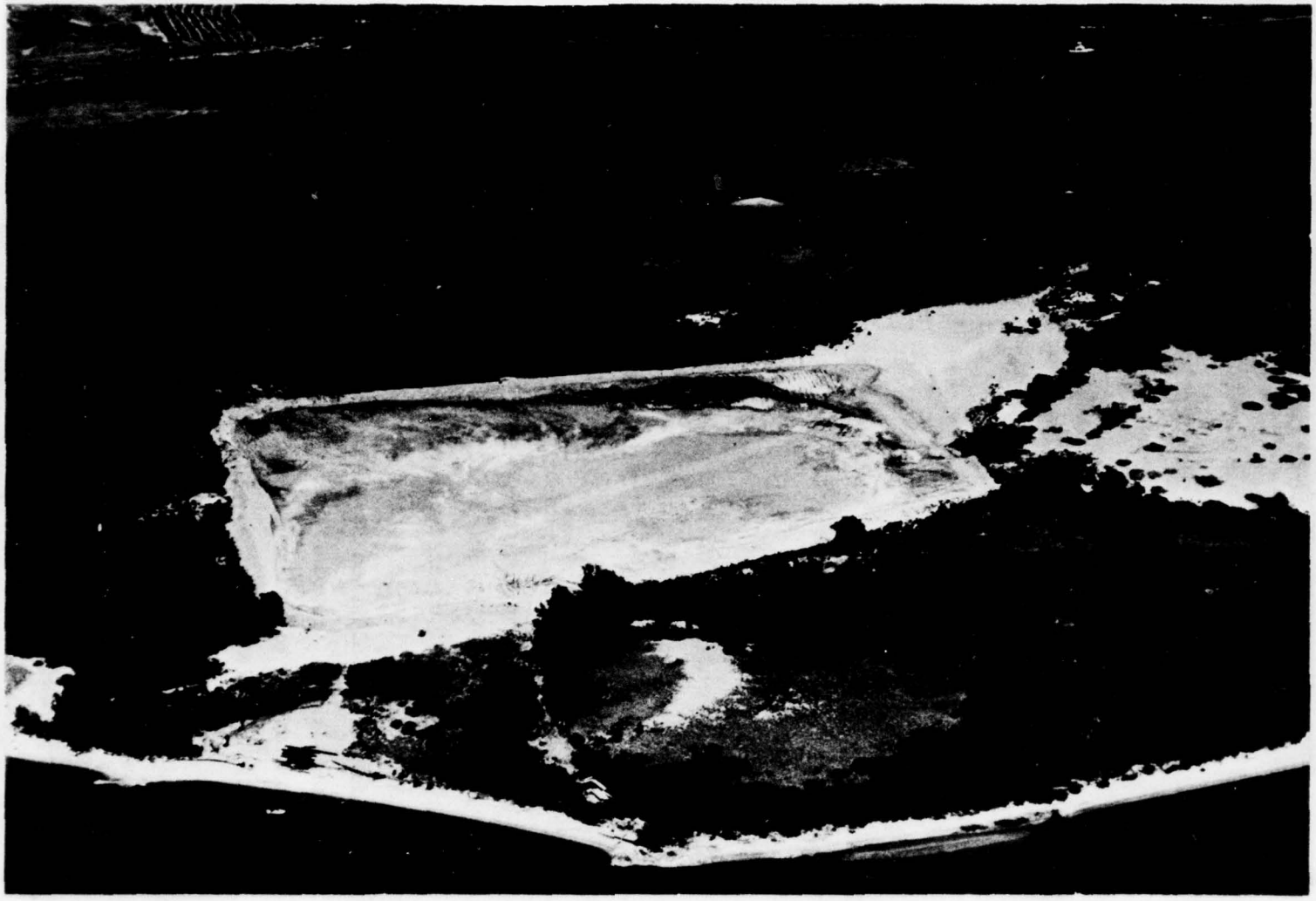


Figure 1. Aerial view of the Nott Island field site in the Connecticut River, Connecticut, showing newly deposited dredged material in summer 1975

Figure 2. Aerial view of the Bolivar Peninsula field site in Galveston Bay, Texas, showing experimental marsh and upland test plots in fall 1977

Figure 3. Aerial view of the Miller Sands field site in the Columbia River, Oregon, showing new deposition adjacent to the existing dredged material island in summer 1975

synthesized in this report. Instructions and advice are provided on the steps in planning, building, and managing an upland habitat development site. A successful project requires interdisciplinary cooperation, since the talents of several physical, biological, and social scientists may be applicable.

4. Additional pertinent literature resulting from the Dredged Material Research Program is tabulated in Smith (1978). Other synthesis reports prepared on habitat development may be useful to the reader. Advantages of and general procedures for developing habitat are given in Smith (1978), and ecological considerations are discussed in Lunz et al. (1978a). Soots and Landin (1978) give guidelines for dredged material island development and management. Environmental Laboratory (1978) provides instructions and advice on developing marsh habitat.

PART II: PLANNING

5. Two situations have potential for upland habitat development. In one, an existing disposal area can be reclaimed or increased in value with a given level of effort. In the other, dredged material disposal from a dredging project will occur at a selected site, and disposal can be planned to meet a habitat goal. The site may be selected for suitability and potential after eliminating alternate sites, but in many cases choice will be limited and planning will involve making the best of a less than optimum situation. Guidance given in this report applies to both situations, with the exception of the steps that deal with the actual disposal process and apply to an active project. It is assumed, in the case of an active dredging project, that habitat development has been selected as the alternative for dredged material disposal.

Site Selection

6. If more than one potential site exists, consider the following criteria for site selection:

a. Availability for disposal and/or development. Questions of ownership and disposal agreements through lease, easement, purchase and removal of fill, land use understandings, or scheduling arrangements are involved.

b. Capacity to meet disposal needs. Capacity of the site is a criterion since the area must be large enough to hold the volume of material to be dredged, whether one-time or repeated disposal is planned.

c. Proximity to dredging project. This relates to the method of dredging and capability of the dredge. Most habitat development sites will be constructed with hydraulic pipeline dredges, which have limitations of distance and height to which material can be pumped without the expense of a booster.

d. Physical and engineering features. Information for preliminary design and assessment of the needs and availability of materials and equipment is needed for site selection. Detailed tests such as analyses of foundation borings are expensive and time-consuming, so they are generally performed only at the selected site.

e. Environmental and social acceptability. Acceptability includes judgment on such factors as alteration of or impacts on existing habitat, relative value of habitats under consideration, protection of wetlands or desirable vegetation, potential for disturbances in water quality or flow, and perception of the project.

f. Tidal and current considerations. Erosion and scour of habitat areas caused by tidal and wave energies are important considerations for determining the longevity and stability of containment structures and habitat development. Interruption of current patterns and changes in the hydraulic regime likely to result from dredged material placement should be examined.

g. Habitat development potential. Potential for habitat development involves the feasibility of and level of effort required for a successful project at the site.

7. Guidance provided in SCS Engineers (1977) on site selection for inland dredged material disposal includes an extensive checklist that would be useful on any project. The site selection process is illustrated in U. S. Army Engineer District, San Francisco (1974).

Site Characterization

8. After the site has been selected, field and laboratory investigations of the site and related areas should be initiated to plan disposal and habitat development operations. If the site is an old disposal area to be reclaimed, it and the surrounding area should be described physically and biologically to assess its potential for habitat development and determine necessary action. If dredging and disposal operations are involved, it will be necessary to add information related to the site's capacity, need for and design of a protective or retention structure, and construction details. This information should be collected in conjunction with characterization of the sediments to be dredged. Coordination among individuals involved in planning the project will improve data gathering efficiency by eliminating overlap in activities such as sampling and map preparation.

Physical and biological
description of the site

9. With an aerial photograph, topograph map, or diagram as a base, record the site's location in relation to the dredging project, other aquatic areas, wetlands, upland areas, and obvious topographic features such as hills or a river bluff. Note cultural points such as areas for housing, transportation, industry, agriculture, water treatment, and recreation. Mark access routes, both land and water, and rate them in relation to equipment that could be transported on them. Use the same scale for all features to show their relationship. Aerial reconnaissance is a good way to become oriented and may reveal features that are hidden from a ground view.

10. Record details of the site such as dimensions, configuration, topography, and elevation. Include mention of dikes, ponds, or other evidence of previous disposal. Note indications of nearby human activity such as a boat dock, cabin, foot trail, or livestock. See Mosby (1969) for techniques on reconnaissance mapping.

11. If the substrate is to be covered with dredged material, give a general evaluation of soils on the site: texture, water content, color, and organic content. If the sediments already in place are to be used for habitat development, some physical and chemical tests must be conducted since soil properties influence the choice of species and potential success of vegetation establishment. Soil analyses should include particle size, available nutrients, pH, salinity, organic matter, and contaminants, if suspected to be present. Table 1 contains an explanation of the importance of these analyses.

12. Details on how to take, prepare, and store samples can be obtained from the laboratory that will perform the analysis. In general, take samples to a depth of at least 15 cm. Each sample for analysis should be a composite of three to five cores taken at random within each area of the site in which the soil appears homogeneous. For routine analysis, samples may be sealed in plastic bags. Contaminant analysis may require that the samples be frozen or placed in a glass container.

13. Existing vegetation and wildlife of the site should be

described. Map vegetation composition and distribution as determined either from visual estimation or sampling with transects or plots. DeVos and Mosby (1969) describe levels and methods of mapping and vegetation analysis that will be suited to site description. Note the specific location of any plants protected by law. A botanist familiar with the area should be consulted for species verification. Current wildlife use of the site should be determined through observation of sign such as tracks or browse marks, actual observations, or some form of sampling. A wildlife biologist familiar with the area can estimate wildlife use of the site and should be consulted about the presence of threatened, rare, or endangered species. Determine species that may recolonize the site. See Giles (1969) and the 1979 fourth edition for various field techniques on wildlife surveys. Additional sampling references are found in Part IV.

Engineering description of the site

14. Field tests required for site characterization and design of a habitat development site are similar to those required in the design of conventional disposal areas, and are outlined here. Palermo et al. (1978) provide detailed testing instructions and should be used as a supplement to this report.

15. Hammer and Blackburn (1977) concluded that substrate foundation investigations are generally conducted in two phases: the first includes a review of information on the geological and subsurface conditions at or near the site and general geological reconnaissance with limited borings and simple soil tests; the other includes more elaborate borings, more extensive soil tests, and other investigations. Detailed information regarding conventional soil sampling equipment and procedures is available in U. S. Army, Office, Chief of Engineers (1972).

16. Substrate investigations are necessary to define foundation conditions and to obtain samples for laboratory tests. Data are needed to estimate potential foundation settlement due to placement of the sediments and, in the case of confined disposal, to design retention structures. If the proposed habitat is to be constructed in an area initially covered by water, grab samples of bottom materials at the

site should be taken for feasibility study purposes in a manner similar to that described by Palermo et al. (1978). These samples will allow general classification of the bottom material and will aid in the selection of boring locations.

17. Borings should be made using conventional soil sampling techniques and equipment. The size of the project and existing foundation conditions at the site, such as uniformity, govern the number and location of borings. It is particularly important to define depth, thickness, extent, and composition of foundation strata and to obtain undisturbed samples of compressible foundation soils. If the sediments are to be confined, foundation borings should be made along the approximate retention structure alignment.

18. If a protective or retention structure or access road is already in place, it should be examined and tested as need be for stability and strength. Consider the soil or other material on site for its suitability in repairing or building a structure or road.

Description of related areas

19. Adjacent habitats should be included in the site description to:

a. Identify a potential source of plant and animal colonizers.

b. Relate the site to other habitats with which it interacts.

c. Determine any adverse impacts that can be avoided or situations that might influence acceptability of the project.

These areas may be ordinarily sampled with less detail than the site itself, with plant species composition and relative distribution or perhaps only the dominant species recorded. Vegetation on areas up to 5 km away should be considered, since it may serve as a source of propagules for natural or intentional plant establishment. A general description of wildlife use of adjacent and nearby habitats will identify potential colonizing species, both desirable and pestiferous. Examine sites from the viewpoint of animal movement potential; e.g., corridors of vegetation or water, distance from similar habitats,

migration routes, and barriers to movement. Areas that might be adversely impacted by habitat development activities (such as a wetland that will be crossed by a disposal pipe or the nest site of an endangered species that should not be disturbed by operations during the breeding season) should be located. Residential or other developed areas and their location relative to the site should be noted.

20. Data on water energy should be part of the site description if the site is situated so that it might be affected by wind and ship waves, flooding, tides, or currents. The information is used to estimate wave runup, dike freeboard requirements, erosion potential, and construction difficulties. The key tidal relationships in establishing and maintaining habitat are the elevation of the water relative to the land, the range of the tidal fluctuation, and the force of the tidal change. In an upland habitat, the reasons for considering tidal range are for establishing final elevations that will not be inundated and for assuring stabilization of containment structures. Tidal ranges are routinely recorded and are readily available from the U. S. Geological Survey.

21. If the site will require a dike for containment, samples from the borrow area will need to be tested for their construction properties. Refer to Palermo et al. (1978) for methods.

22. The waterway or harbor to be dredged must be surveyed to determine the volume of sediments to be moved and sampled to provide material for physical and chemical laboratory tests. Hydrographic survey methods are well established and are an integral part of any dredging project. The level of effort required for sediment sampling is project-dependent. In routine maintenance dredging, the scope of the field investigations may be reduced by use of data from prior samplings or by experience gained from working with similar material. More extensive investigations will be required for large maintenance and new work projects. Grab samples of the sediments to be dredged are satisfactory for laboratory analyses for most habitat development. However, for new dredging work, samples of sediments from borings are required. For engineering purposes, procedures for determining type, location, and quantities of samples, for preservation of samples, and for using sediment sampling

equipment are described in Palermo et al. (1978).

Laboratory tests

23. Samples to determine suitability of the sediments for plant growth should be analyzed for particle size, available nutrients, sulfates, salinity, organic matter, and suspected contaminants. Either soil testing laboratories in the land-grant university of the state where the site is located or commercial testing facilities may be used for laboratory analysis of soil samples. Contact the cooperative extension service or agronomy department of the university or refer to Appendix A of this report for a partial list of commercial testing facilities.

24. Engineering tests for containment area design have been described by Montgomery (1978) and Palermo et al. (1978) and are suitable for habitat development purposes. In addition, laboratory testing procedures described in U. S. Army, Office, Chief of Engineers (1970a, 1970b) outline the applicability of various tests that simulate actual field loading conditions. The laboratory testing program should provide:

a. A description of the physical and engineering properties of the material to be dredged.

b. An understanding of the sedimentation and consolidation characteristics of the slurry resulting from dredging.

c. Data for containment area design.

Specific tests are predicated on whether the dredged material is classified coarse-grained (>No. 200 sieve) or fine-grained (<No. 200 sieve). Tables 2 and 3 contain the various tests that may be required in the laboratory testing program.

25. Sediment characterization and column sedimentation tests are needed for defining the sediment and its retention and protection requirements and for predicting sediment behavior during dredging and disposal. Visual classification will establish whether the sediment sample is predominantly fine-grained or coarse-grained. Samples that are a mixture of both must be separated with the No. 40 sieve prior to testing. Coarse-grained materials require only grain-size analysis. Results of these tests can be used to classify the sediments according

to the Unified Soil Classification System (U. S. Army Engineer Waterways Experiment Station 1960). Particle size distribution is also important in defining the sediments: well sorted material can be more effectively deposited than poorly sorted material.

26. Sedimentation and consolidation tests are performed on fine-grained sediments to provide data regarding sedimentation and self-weight consolidation behavior. They will provide data for designing a containment area that will meet effluent suspended solids criteria and provide adequate storage capacity for the amount of dredged material available. Sedimentation tests are performed in approximately 20-cm-diameter columns, with separate test procedures used for saline (>3-ppt) and fresh (<3-ppt) sediments. Sedimentation tests define flocculent or zone settling behavior characteristics of the dredged material. Following sedimentation testing, standard consolidation tests are performed to define self-weight consolidation behavior.

Goal Definition

27. Although the overall objective of habitat development may be understood, a refined and specific goal or management target is needed. There are no national goals for wildlife to guide the planner, except for efforts to restore endangered species and avoid creating more (Lyon 1978). So the planner should consider the most appropriate management system, local and regional needs and opportunities, target species needs, current and planned use of the site, available funding, and site- or project-specific constraints in determining the goal. Lunz et al. (1978a) offer additional aid in this decision. A method to establish logical and reasonable objective statements is described in Phenicie and Lyons (1973).

Management systems

28. Two basic forms of management systems exist: featured species and species richness. As discussed by Black and Thomas (1978), the former involves selection of a species or species group and is directed to fulfilling its habitat requirements through management.

The goal is a certain population level or habitat status or both. In the latter, maintenance of most or all species in viable numbers within a particular area is attempted, which means managing for diversity and quality of the overall habitat. The trend in land management agencies seems to be toward species richness management, but featured species management is suitable for such targets as a game population, an endangered species, raptors, or colonial waterbirds. A disposal site might be managed to contribute to the diversity of a larger area or to provide a habitat need of a featured species.

29. Featured species management is sometimes not as successful as it could be because of inadequate information on exact food, space, nesting, or other requirements of a species. But continuing research will fill in details, and there is enough information to attempt such management (Thomas et al. 1976). Species richness is, in some ways, a more demanding system because of the large number of species involved and the possibility of negatively affecting one species while benefiting others. An approach taken by Haapanen (1965) to reduce the number problem involved classifying bird species into ecological groups by feeding habit and by nesting habit, then relating the groups to vegetation characteristics. This concept has been put into management practice by Thomas et al. (1976) in forest systems in Oregon and Washington, where 379 vertebrate species were placed into 16 life forms. Thomas (1979) describes the process in detail. Considerable research on vegetation and wildlife species relationships has been done and provides a basis for these categorizations; e.g., Anderson and Ohmart (1977), Anderson and Shugart (1974), Haapanen (1966), and Wiens (1969).

Local and regional
needs and opportunities

30. What species of wildlife live in the area? They may be placed into categories or species groups for ease of consideration: furbearers, game mammals, predatory mammals, other mammals, upland game birds, ducks and geese, shorebirds, predatory birds, nongame and songbirds, reptiles, and amphibians. For selection of habitat development targets, species of commercial, recreation, and social or legal

importance come to mind immediately, but support species also deserve consideration. Support species provide a trophic base for other organisms (Lunz et al. 1978a), and management for them is usually at a low level of effort. Nongame wildlife species, especially birds, are receiving an increasing amount of management attention (Smith 1975), and many species are particularly suitable goals in an urban setting.

31. Species considered threatened, rare, or endangered merit particular attention and will respond to featured species management. The 1973 Endangered Species Act prohibits Federal action that might put protected species and their habitat in jeopardy. A complete list of Federally designated endangered and threatened wildlife and plant species was published in the Federal Register on 11 December 1978. Opportunities to improve their status through habitat development should be sought. Contact the Endangered Species Program Manager, U. S. Fish and Wildlife Service, Department of the Interior, Washington, D. C. 20240, for updated information on Federally protected species and their habitats. That office also publishes a monthly newsletter, The Endangered Species Technical Bulletin, which provides current information on the status of endangered species and proposed rule-makings. The appropriate Regional Endangered Species Coordinator of the U. S. Fish and Wildlife Service (Table 4) can also supply this information. See Coastal Zone Resources Division (1978) for a partial list of state publications on protected species, or contact the appropriate state's department of wildlife and fisheries or natural resources.

32. Recovery teams have been formed for 81 animal species (64 teams) as of November 1978 and should be consulted for advice before beginning a project that might affect one of those 81 species. The name and address of team leaders can be obtained from the appropriate Regional Endangered Species Coordinator.

33. Critical Habitat has been designated for 34 endangered species as of November 1978 and proposed for an additional 76. This designation means that the area defined includes habitat that cannot be destroyed or adversely modified through action by a Federal agency. A disposal site within Critical Habitat must be in compliance and might

be managed to benefit the species. Contact the appropriate Regional Endangered Species Coordinator to see if the site might be involved. Critical Habitats are published in the Federal Register as they are proposed and finalized.

34. Not just the species present but its local population level is a consideration in defining the project goal. The planner may wish to avoid developing habitat for a locally overabundant species such as the ring-billed gull* in the Upper Great Lakes, to destroy habitat and decrease populations of pest species such as the Norway rat, or to provide additional breeding habitat to increase numbers of insectivorous songbirds. The planner should maintain compatibility of wildlife and existing land use; e.g., not build a waterfowl nesting site next to a vegetable truck farm.

35. Secondary objectives beneficial to the local situation may determine the project goal.

a. Existing recreation facilities such as a park might be extended onto the disposal site, combining conservation education activities with wildlife management to encourage species tolerant of human presence.

b. If a site is in a residential area or in a location easily seen by people, aesthetic appearance is very important and the area may require landscaping (Mann et al. 1975).

c. Soil erosion control is desirable from an aesthetic, water quality, and land stewardship standpoint and is a necessity on some substrates.

d. Soil improvement can be an intermediate goal, preparing the site for another use.

Target species needs

36. All species have times of particular stress, including especially periods of reproduction, overwintering, and migration. Management to improve conditions during any of these periods will be beneficial. Reproduction activities usually require isolation, adequate food, and cover. During the winter, food and cover are critical. Since disposal areas are often located in migration corridors of waterfowl,

* Common and scientific names of all animals and plants mentioned in this report are listed in Appendix B.

shorebirds, songbirds, and waterbirds, a good management opportunity is provision for some needs of a migratory species; e.g., staging, resting, or feeding areas. The Windmill Point marsh development site in the James River, Virginia, a disposal area built to field test habitat development, served as a resting area for migrating shorebirds (Wass and Wilkins 1978), illustrating this feasibility. A complete list of migratory birds is given in the Federal Register, Volume 42, No. 221 (corrections in Volume 43, Nos. 50 and 69).

37. Habitat and life requirements for individual species or groups are found in such references as Bellrose (1977), Coastal Zone Resources Division (1978), DeGraaf (1978), Ingles (1965), Jackman and Scott (1975), Lowery (1974a, 1974b), Martin et al. (1951), McAtee (1939), Parnell et al. (1978), Parnell and Soots (1975), Schwartz and Schwartz (1959), Smith (1975), Soots and Landin (1978), Soots and Parnell (1975), Trimble (1975), and Trippensee (1948, 1953).

Use of the site

38. Current human and wildlife use of the site is a consideration in defining the goal, since that use will be either restored or modified following disposal and habitat development. Potential use plans will affect goal definition, often as a constraint. For example, on land slated to be a park, either wildlife will have to be tolerant of human access or such access will have to be restricted by season or location. On dredged material that will be used as an industrial foundation when it has settled and consolidated, the goal will have to be short-term. Uses near the site may also impact goal definition; e.g., establishing a bird roosting area next to an airport would be inadvisable.

Funding

39. Both the project goal and the detail or sophistication of steps taken to meet it will depend on the size and availability of the budget. Answer these questions:

a. How much money is available?

b. When will it become available?

c. Over what period of time is the money available?

d. How certain is the funding?

e. Are there items for which it cannot be used?

f. Are there time limits on its expenditure?

The objective probably will have to be scaled to the budget and may vary from intensive management and annual maintenance to encouragement of natural plant colonization.

Disposition of the site

40. Ownership and/or responsibility for the condition and operation of the habitat development site must be determined. If ownership is fixed, some flexibility exists in goal definition. Disposal areas are often leased, however, or turned back to the owner after filling. Only short-term development may be possible, or that specified by the owner. The site may have to accommodate several disposal operations over a period of time; habitat development will then be either cellular or sequential.

Constraints

41. The planner may encounter constraints on the goal from a number of directions. The site itself may be unsuitable for certain purposes because of its location, configuration, size, access, current or planned use, etc. Funds may be limited or unpredictable. The owner or responsible individual, the community, or a concerned agency may not favor the determined goal. The dredging and disposal operation itself is often variable and unpredictable, requiring flexibility in planning. The need for periodic or regular disposal will eliminate some goals just as the lack of redisposal will eliminate others. The project objective may have to change with time if sequential disposal occurs.

Relation of Site and Goal

42. As project planning advances, it will be necessary to maintain coordination among all individuals and agencies to avoid conflict or duplication of effort. The planner should be able to modify the site characteristics or project details as possible and the goal as necessary to make the two compatible. This flexibility should begin early in planning and continue for the duration of the project.

Method of Vegetation Establishment

43. Although an animal's habitat consists of a wide variety of components, vegetation is by far the most important. Vegetation growth form, height, density, placement, diversity or uniformity, seasonal changes, biomass, and hardiness strongly influence species composition, abundance, and well-being of wildlife. Secondary objectives of recreation, aesthetics, erosion control, and soil quality also depend in part on vegetation. These relationships make it necessary to begin consideration of the ultimate vegetation of the site early in the planning process.

44. Three methods of vegetation establishment exist:

a. Allow natural plant invasion and establishment.

b. Plant selected species.

c. Combine natural establishment and planned propagation.

Natural invasion and establishment

45. Potential. The ability of propagules to reach the site is the most important factor in describing the potential for natural colonization. This ability increases as the distance from a propagule source decreases and as the size of the site and ease with which the propagule can be transported increase. Propagules may be transported over a distance by wind or water, by attaching themselves to an animal's fur or feathers or feet, by being ingested and excreted by an animal, or by attaching to a human. Secondary factors in the potential for natural colonization include physical and biological features of the site itself. Plants growing and reproducing on the site will reestablish after deposition of dredged material if the deposit was not too thick and if new substrate conditions are not prohibitive. Plants growing and reproducing near the area will establish only if seeds blow or are carried onto the site, if rhizomes or other vegetative reproduction forms extend onto the site, and if the new substrate conditions are not prohibitive.

46. An ideal island for natural vegetation establishment, based on work reported in Soots and Landin (1978), would be:

a. Located within 5 km of another area with vegetation.

b. At least 10 to 15 ha in size.

c. Less than 3 to 5 m above tide or flood stage at a propagule access point, and still accessible to the water table.

d. Relatively even in topography and elevation or at least with gentle variation.

e. Protected from water or wind erosion.

f. In a freshwater area.

g. Of sorted pebbles, sand, or silt substrate with adequate nutrients and no growth inhibitors.

h. Free from intensive animal or human use.

47. Advantages. If the pattern of vegetation resulting from natural colonization is desirable, four advantages accrue:

a. Development efforts are limited to increasing the likelihood of plant invasion through site selection (proximity to source), project design (favorable conditions), or preventative measures (fencing).

b. Development costs are limited to the efforts described above.

c. The invading species that are successful are those best suited to site conditions and may be expected to outcompete other species that will not grow as well.

d. Maintenance is minimal.

48. Disadvantages. There are three possible disadvantages of which the planner should be aware:

a. Invasion and establishment of undesirable plant species. This can occur even if desirable species are nearby for propagule sources. A good example is common reed, a vigorous invader of high marsh to upland areas in the east and gulf coast areas. Once this plant colonizes, eradication is almost impossible, control with herbicides and mowing is difficult, and invasion by other species is unlikely.

b. Slow rate of colonization. Studies on natural vegetation colonizing approximately 200 dredged material islands throughout the United States (Soots and Landin 1978) showed establishment to occur over a period of up to 30 years, with some sites never being vegetated. Elevated sandy deposits such as are often found along riverbanks may take years to vegetate, and sediments of marine

origin will not be colonized until the salinity level decreases adequately, which can take several years. This means that substrate stabilization and provision of habitat are delayed.

c. Undesirable wildlife species. In a natural system where no control is exercised over the colonizing vegetation, undesirable wildlife may also colonize the area. Norway rats commonly invade disposal areas with the dredging equipment, supply boats, etc., and will probably establish on the site if weedy vegetation or river debris exists.

Planting selected species

49. Potential. Standard practices in agronomy are usually sufficient to handle plant propagation on upland sites. With appropriate planning and management, any site can be vegetated within a few years and most sites within a year.

50. Advantages. The effort involved in planting a site results in four advantages:

a. The most suitable vegetation to meet the project goal will be present.

b. Substrate stabilization will occur rapidly, from top growth catching sediments on the surface and root growth spreading and stabilizing below the surface.

c. Plant species can be selected for their ability to ameliorate a specific soil problem, such as planting legumes to increase nitrogen content.

d. Aesthetic appearance of the site is improved.

51. Disadvantages. There are also disadvantages:

a. Prior planning and effort are required to locate, obtain, and prepare the appropriate propagules.

b. Lead time is needed to allow for seed harvest and dormancy or for growing transplants.

c. Arrangements and facilities must be made to handle, store, and treat the propagules.

d. Scheduling of disposal operations so the planting substrate can be ready at the correct time of year for plant success is often difficult.

e. The soil may require extensive modification to prepare a seedbed.

Combining natural establishment and planting

52. A combination of the two methods of vegetation establishment may be beneficial. One can allow invasion to stabilize the substrate and start modifying the sediments, then plant a different type of vegetation when the season or timing or soil conditions are more suitable. The reverse also is possible: to get immediate benefits of selected plantings, then allow the site to proceed in natural successional stages.

Selecting Plant Species and Propagule Type

Selecting plant species

53. If the site is to be planted, advance consideration must be given to the plant species that will create the desired habitat for the target wildlife species. An initial selection of species should be made during the planning phase, even though once the site is established, alternate species may prove to be more acceptable and be substituted for those originally selected. Numerous species are suitable for planting upland dredged material sites. Coastal Zone Resources Division (1978) identified, by state, 250 species or species groups that are of benefit to wildlife and adapted to grow on dredged material and presented species growth characteristics, habitat requirements, ranges, and tolerances of 100 of these. Lee et al. (1976a) identified 50 species and genera useful for dewatering and decontaminating dredged material. Mann et al. (1975) gave growth characteristics of many tree and shrub species suitable for confined upland disposal areas. Coastal Zone Resources Corporation (1977) and Soots and Landin (1978) summarized data on plants known to grow on dredged material sites.

54. Other species of more local character are available, and many species with unknown tolerances and adaptability may prove useful after field testing. Local soil conservation service personnel and agronomists will be able to provide updated information on species and new varieties. Table 5 contains a list of 360 species that might be selected and comments on their propagation and growth. A companion listing

(Table 6) gives the geographical locations, soil tolerances, and values of these species.

55. Selection of the species or species mixture to be planted at a particular site should include the following considerations:

a. Project goals. Knowledge of the target wildlife species habitat requirements is necessary. Major sources for such requirements are given in paragraph 37. Choose species that will meet the goal in a reasonable length of time or advance toward the goal. For example, a long-range objective of providing nest sites for colonial tree-nesting waterbirds by planting wax myrtle, marsh elder, and groundsel will take 3 to 10 years to achieve but could be augmented by planting clumps of saltgrass to encourage a goal of ground-nesting by gulls and terns. These plantings would be based on knowledge of the species nesting requirements.

b. Climate and microclimate. Climatic factors of precipitation, temperature ranges, wind patterns, and frost-free days control the major patterns of vegetation distribution. Microclimate features such as slope and topography control more localized patterns. The site's location, then, will automatically restrict selection to plants able to grow there. Plant only those species with universal ranges such as many agronomic crops or those that can be obtained in the area.

c. Substrate characteristics. Dredged material is considered a soil (Bartos 1977a) but is variable in texture and components, depending on its source. Sediments placed upland may be sandy and infertile, fine-grained and contaminated, saline, acidic, split by desiccation cracks, or have other characteristics that limit plant growth. Species selected should be tolerant of the soil conditions expected at the site.

d. Plant species characteristics. Considerations include:

(1) Basic growth requirements.

(2) Tolerances to extremes of temperature, light, moisture, pH, salinity, contaminants, and nutrients.

(3) Growth form (viney, upright, spreading, etc.).

(4) Rate of growth and life span.

(5) Form and flexibility of reproduction.

(6) Production of wildlife food and cover (quality, amount, form, time, and duration).

(7) Competitive ability, including inhibition of other species.

(8) Ability to modify site conditions (decrease wind erosion, add nitrogen to the soil, etc.).

(9) Hardiness.

(10) Resistance to insect and disease damage.

(11) Need for maintenance, management, or control.

Select species either with the appropriate tolerances, reproduction capabilities, etc., or with wide ranges of characteristics necessary to cope with site conditions.

e. Availability. Numerous species may be acceptable but not available because of time, economic, or manpower reasons. This is a strong possibility if the plant species is not commercially available. Appendix C gives a partial listing of Federal, state, and commercial sources of plant propagules.

f. Ease of propagation. Unless an easily handled form of propagule can be found for a species, that species will be of little use in a vegetation establishment and management scheme. In general, upland species are seed producers so that seeds can be collected in varying quantities for planting. When this is not the case, as with Calley Bermuda grass, a hardy, rapid-growing, nutritious, but sterile plant of the southern United States, sprigs, root stock, or cuttings must be used.

g. Management requirements. After establishment, intensive or frequent maintenance of the plants such as pruning or hand-weeding is costly and inefficient. Selection of species requiring such care to survive should be avoided. Plan for a low level of maintenance, such as seasonal mowing or periodic fertilization. Management or control of a species that can become established to the detriment of others should be considered, and that species either not planted or control measures guaranteed. Examples of such species are Japanese honeysuckle, kudzu, and Australian pine.

h. Costs. Regardless of what favorable characteristics a species has, if obtaining and planting the propagules will cost more than the available funds, it is not a feasible selection. Costs will generally be lower if a commercial seed source is located than if hand collection of seeds is necessary. Costs are usually lower for seeds than for vegetative propagules, since the latter require more harvesting labor, storage space, elaborate handling techniques, and transplanting labor. Vegetative propagules are usually only cost-beneficial when trees or shrubs are planted.

56. Certain species mixtures are commonly planted, such as a

clover and a grass species, to take advantage of the different properties of each. Occasionally the mixture will not be successful because of interactions between the species. For example, studies by McKell et al. (1969) showed annual ryegrass had a detrimental effect on growth of some other species.

Selecting propagule type

57. Tables 5 and 6 give the best propagule types for selected plant species, based on criteria of availability and cost, ease of collection and handling, ease of storage, ease of planting, occurrence of disease, and need for rapid vegetation establishment. These criteria are discussed in Table 7. In general, seeds are cheaper and easier to work with than vegetative propagules such as cuttings, sprigs, or seedlings. But some plant species and planting situations require vegetative propagules; e.g., to rapidly stabilize the exterior of a sand dike.

Handling plant material

58. If commercial seed sources are not available, collection and storage of wild seeds should follow the guidelines in Table 8. Some desirable species are available as transplants (potted, balled and burlapped, or bare-rooted nursery stock). However, many upland plants that are desirable as long-term cover and food sources, such as trees and shrubs, are not commercially available. Wild plants may be collected by the guidelines in Table 9.

Engineering Design of the Site

59. Guidelines for substrate design and sediment protection and retention apply to a new disposal area or one that may already have a retention structure and some material placed. Design should be based on information gathered during the site description, on results of field and laboratory tests, and on the requirements for the planned habitat development. The majority of the information in this section was compiled from Palermo et al. (1978) and Eckert et al. (1978).

60. Dredged material may be placed by either hydraulic or mechanical methods. Johnson and McGuinness (1975) stated and this

discussion assumes that the hydraulic pipeline dredge is the most commonly used and will continue to provide the major source of material to be used for habitat development. Hydraulic transport of material assumes additional prominence when one considers that the newer concepts for dredged material handling systems, involving direct pumpout of hopper dredges, temporary containment basins, or bucket-loaded scows, usually involve final disposition by pipeline. The pipeline dredge can dispose of material in shallow water areas through the use of shore lines or shallow-draft floating pipelines.

Substrate design

61. Substrate design for upland habitat development includes determination of site elevations, slope, orientation, configuration, and size (area and volume). The design must provide for placement of dredged material to a stable elevation within the desired elevation limits, allowing for settlement due to consolidation of both the sediments and foundation material. For fine-grained sediments, the substrate must be designed to provide adequate surface area and retention time for sedimentation of suspended solids. Procedures for substrate design generally follow those established by Montgomery (1978) and Palermo et al. (1978) for the design of conventional containment areas. Mann et al. (1975) provide a discussion of design for the nonengineer.

62. The determination of substrate elevation is governed by two limitations:

a. The project requires placement of a given in situ channel sediment volume, and the size to handle this volume within elevation limits must be determined; conversely,

b. The project requires a substrate to be constructed within given size limits, and the volume of in situ channel sediment to construct this substrate must be determined.

In either of the above cases, a correlation between in situ sediment volumes and volumes occupied by the dredged material must be determined. The first step is to calculate in situ void ratios by determining water content of samples of the sediments to be dredged. The second is to compute the void ratio of the dredged material after dredging and deposition. These calculations can be made using the techniques and

examples outlined in Montgomery (1978) and Palermo et al. (1978) for dredged material containment area design.

63. Sedimentation of solids. Confined disposal areas with primarily fine-grained dredged material should be designed to retain solids by gravity sedimentation during the dredging operation. Solids retention is directly affected by the size of the confinement area (particularly length and depth), inflow rate (dependent on dredge size and operation), physical properties of the sediment, and salinity of the water and sediments. Montgomery (1978) and Palermo et al. (1978) detail separate design procedures for determining sediment retention time requirements for fresh and saline sediments with continuous disposal. In addition, these procedures include factors influencing efficiency of the substrate containment, effects of short-circuiting, ponding depth, weir placement, and shapes of containment. In the event that substrate containment does not provide an adequate gravity sedimentation basin, then one of the following alternatives must be exercised:

a. The size of the site must be increased.

b. A smaller dredge must be used.

c. Intermittent dredging and/or disposal operations must be initiated.

64. Weir design. Retention structures used to confine dredged material must provide a means of releasing carrier water back into the waterway, which is best accomplished by placing a weir within the containment area. Effluent quality can be strongly affected by the design and operation of the discharge weir, with the weir length and ponding depth having the greatest control on this quality. Walski and Schroeder (1978) developed a design procedure for defining weir length and ponding depth to minimize the discharge of solid particles into the waterway.

65. Dredged material settlement. Settlement will occur following completion of the dredging operation because of the self-weight consolidation of the dredged material layer and/or the consolidation of compressible foundation soils. Estimated settlements may be determined by procedures presented by Palermo et al. (1978). Once loading

conditions are determined, ultimate settlements that occur after the completion of 100 percent primary consolidation can be estimated from laboratory consolidation data. Time rates of consolidation described by Palermo et al. (1978) for both the dredged material and foundation soils are required to determine the relationship between the desired final substrate elevation and time. If the data from the laboratory tests reveal that settlement will not meet desired elevation requirements, an adjustment to the substrate configuration must be made to raise or lower the initial substrate elevation as required. If a limited volume is to be dredged, the proposed areal limits of the site may be adjusted. If site size is limited, the proposed dredging volume may be adjusted or an additional disposal site located. Settlement may then be recomputed and comparison again made with elevation requirements.

Substrate protection and retention

66. Requirements for a structure. Data gathered for the site description should be used to determine if a protective or retention structure will be needed. Engineering data collected at a specific site should determine: amount and character of material to be protected or retained, maximum height of dredged material retained above the firm bottom, degree of protection from waves and currents required, duration of the structure, foundation conditions at the site, and availability of construction material.

67. Habitat development sites may require a structure for protection of the perimeter from erosion caused by currents, waves, or tidal action. Particular concern should be given to the effects of any proposed structure on existing current or wave patterns. A structure positioned so it constricts the water flow will increase local current velocities or reflect wave energies and thus may encourage erosion. Habitat development sites may require structures for retention of the dredged material to allow it to consolidate, to control the suspended solids content of the effluent, or to protect surrounding habitat or adjacent structures. Site hydraulics, the properties of the sediment to be dredged, the time over which disposal will occur, and

existing site characteristics are closely interrelated in determining the need for such structures.

68. Selection of structure. The protective or retention structure should meet four conditions:

a. Suitability to the project goals of dredged material disposal and habitat development.

b. Practicality and ease of construction.

c. Ease of maintenance.

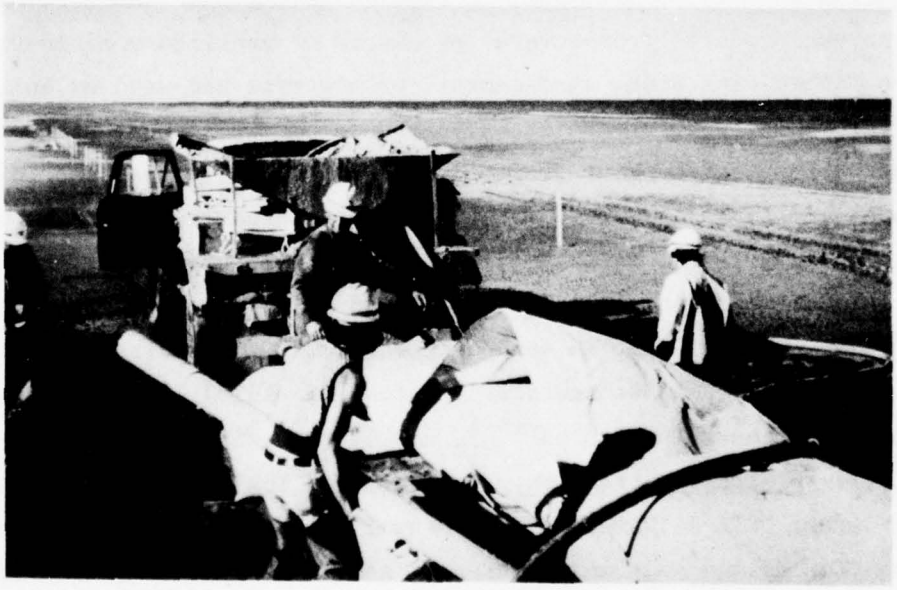
d. Reasonableness of cost.

69. Eckert et al. (1978) evaluated several protective and retention structures considered technically feasible for use in terrestrial habitat development and presented information on structure selection, applicability to specific site conditions, and conceptual procedures for design and construction. This information is summarized in Table 10.

70. The most feasible structures are often dikes constructed from filled fabric bags or from sand (Eckert et al. 1978). The term "fabric bag" covers products from several producers of sacklike containers that can be filled with sand, sand-cement, or concrete and used as building blocks for breakwaters, groins, revetments, or containment dikes. Two recent habitat development projects have successfully used fabric bags: Allen et al. (1978) describe construction of a fabric bag breakwater in Galveston Bay, Texas; and the Wilmington District used bags for dredged material retention and island construction in Core Sound, North Carolina (Soots and Landin 1978). A sand dike was built for habitat development on a disposal area in Connecticut (Hunt et al. 1978). These three projects are shown in Figures 4, 5, and 6, respectively.

71. Design of structure. Two Corps of Engineers design manuals (U. S. Army, Office, Chief of Engineers 1970a, 1971) provide proven methods for design and construction of earth and rock-filled structures. Those procedures should be used to supplement the following definitions and guidance:

a. Dike construction



b. Fabric bag filling

Figure 4. Fabric bag dike construction operations at the Bolivar Peninsula field site in Galveston Bay, Texas

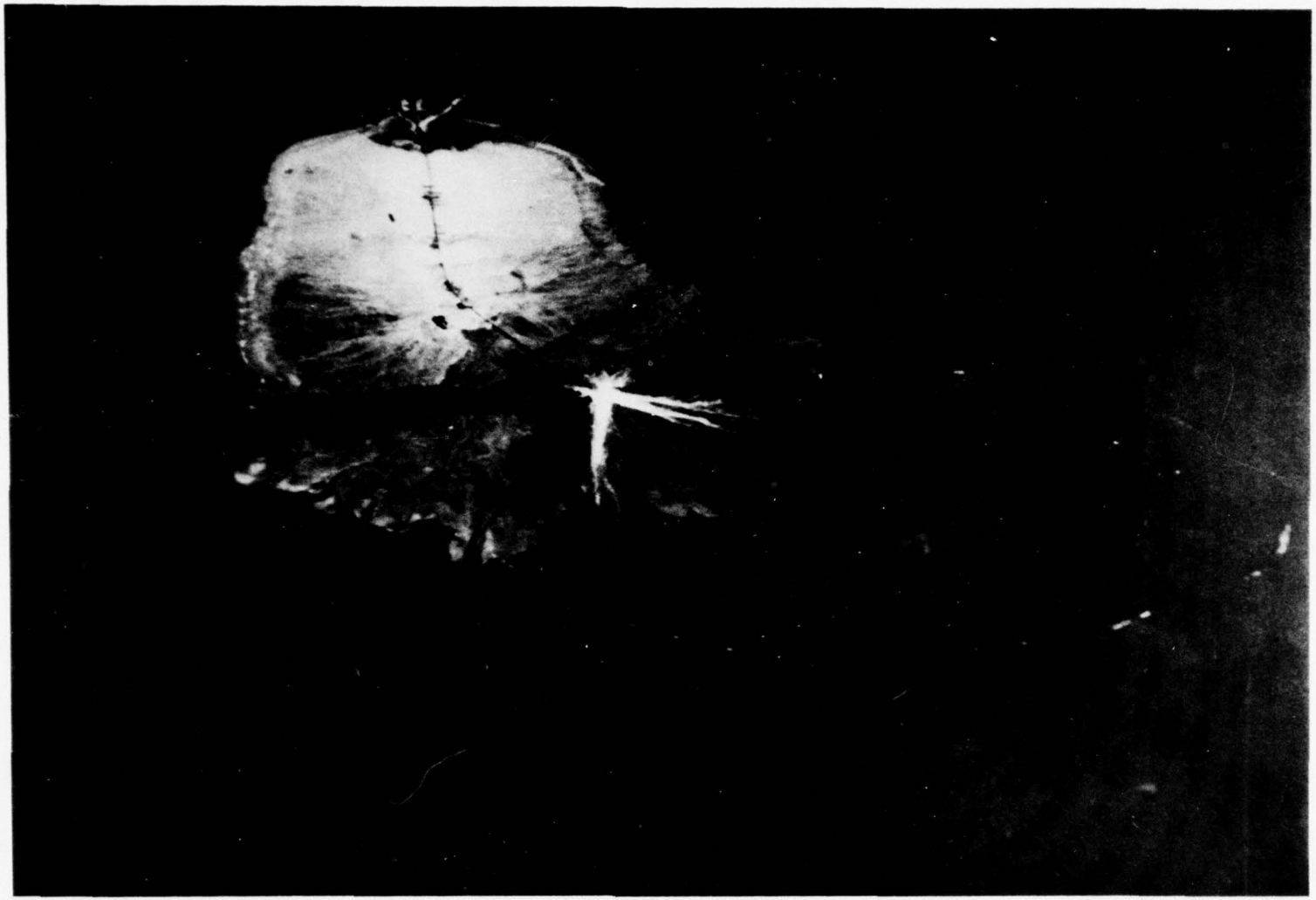


Figure 5. Aerial view of a dredged material island in Core Sound, North Carolina, constructed for seabird nesting by the Wilmington District using fabric bag dikes

Figure 6. A temporary sand dike built to retain dredged material at the Nott Island field site in the Connecticut River, Connecticut. The dike was removed after consolidation of the dredged material

a. Elevation. Guidelines for elevation are derived from:

(1) Limits placed by the need to avoid adverse soil conditions in deposited sediments; e.g., high, droughty soils.

(2) The requirement to contain a given volume of material.

(3) The need to maintain a ponding depth.

(4) The need to allow sufficient freeboard to avoid storm erosion and/or overtopping by waves or high tides.

b. Forces. Consider earth and water pressure forces acting on the structure and anticipated surcharges encountered during disposal. The worst case condition is encountered immediately following dredging (Eckert et al. 1978).

(1) Waves. Ship waves should be measured in timing with ship traffic. Wind wave forces can be predicted from data on height, period, direction, and probability of occurrence and by methods described in U. S. Army Coastal Engineering Research Center (1977). That source also discusses erosion, scour and deflection forces and methods to minimize their effect. Erosion control, site location, and shape are discussed in Johnson and McGuinness (1975) and Hammer and Blackburn (1977). Protective structures are covered in Eckert et al. (1978).

(2) Foundation settlement. Evaluation of the soil bearing capacity, the stress distribution caused by the retaining structure, and the expected settlement of the structure is essential. Methods for calculating bearing capacity and settlement are presented in U. S. Army, Office, Chief of Engineers (1953, 1958). If settlement will be significant, allowances must be made in the design of the retaining structure.

(3) Seepage and piping. Seepage is the flow of water through a saturated soil mass caused by unequal heads between two boundary surfaces. The amount of water that flows in this manner depends on the head differential and permeability of the material through which the flow takes place. If water flow is sufficient to remove the sand at a point on the downstream boundary surface, head loss is gradually decreased and erosion retrogresses through the embankment like an ever-enlarging pipe, hence the term "piping." Hammer and Blackburn (1977) discuss seepage and piping and give methods for minimizing their occurrence.

72. Internal structures may be advisable. Cross and spur dikes are used to control circulation within a disposal area, with the cross dike commonly employed to divide large disposal areas into smaller cells, and spur dikes employed to interrupt direct slurry routes between the inlet and outlet. The cross dike is the more significant of the two structures for habitat development purposes, since use of a cross dike allows flexibility in disposal including incremental filling and separation of dredged material by grain size.

73. Construction of structure. According to Eckert et al. (1978), site-specific factors affecting construction techniques are:

a. Equipment accessibility.

b. Wave and current conditions.

c. Tidal range.

d. Water depth.

e. Bottom conditions.

f. Distance from dredging site.

74. The construction material used and method of construction are significant factors. In addition to the fabric bags discussed in paragraph 70, three basic types of retention structure construction exist (Hammer and Blackburn 1977):

a. Hauled dikes. These are built by fill, which is usually hauled by trucks from borrow areas. The main advantage of this type of dike is that it results in the highest quality structure occupying the least amount of space; its main disadvantage is its relatively high cost.

b. Cast dikes. These are built by casting material up with draglines. This procedure, which has been extremely popular in the past because of its relatively low cost, involves the use of a borrow ditch located parallel to the dike.

c. Hydraulically placed dikes. The pumped or hydraulic fill method of dike construction consists of excavating material with a dredge and pumping it hydraulically to the desired area. This technique is usually the most economical of dike construction methods because it can combine in one operation both excavation and transportation of material over long distances. It was used at a habitat development site in Virginia (Lunz et al. 1978b). Construction material is generally limited to sand.

Construction techniques for retaining walls, sills, breakwaters, gabions, and other structures are highly site-specific and should be determined on a case-by-case basis. For a description of construction methods, see Hammer and Blackburn (1977).

75. Hand et al. (1977) summarize operating characteristics and production capabilities of dredging equipment used in this country (Table 11). Information of this nature, e.g., newer hydraulic dredging equipment has an effective disposal distance of 2100 to 3000 m and effective height of 6 to 12 m, will impact site design. Johnson and McGuinness (1975) summarize equipment normally used for material handling and shaping operations in and around dredged material disposal areas (Table 12).

Ecological Design of the Site

76. Planning for a habitat development site should be based on sound ecological principles and should attempt to make efficient use of available resources in reaching the goal. The two major resources that can be manipulated for habitat development are substrate (in this case, dredged material) and vegetation. All previous aspects of planning should be united in the ecological design of the site for proper placement of dredged material and vegetation.

Placement of dredged material

77. Many aspects of the engineering design of a disposal site are directly related to the site's potential biological characteristics. Physical appearance of the site is particularly important.

a. Structures. Presence or absence of a protective or retention structure can lead to varying rates of plant and animal colonization, control species composition, and may affect survival rates of young animals reared on the site. Parnell et al. (1978) examined dike placement on dredged material islands in North Carolina and should be consulted for specific examples. A structure's form, height, continuity, and durability affect the biological properties of the site. A permanent, unvegetated dike in Toledo Harbor in Lake Erie (Figure 7) has served as nesting substrate for common terns, ring-billed gulls,

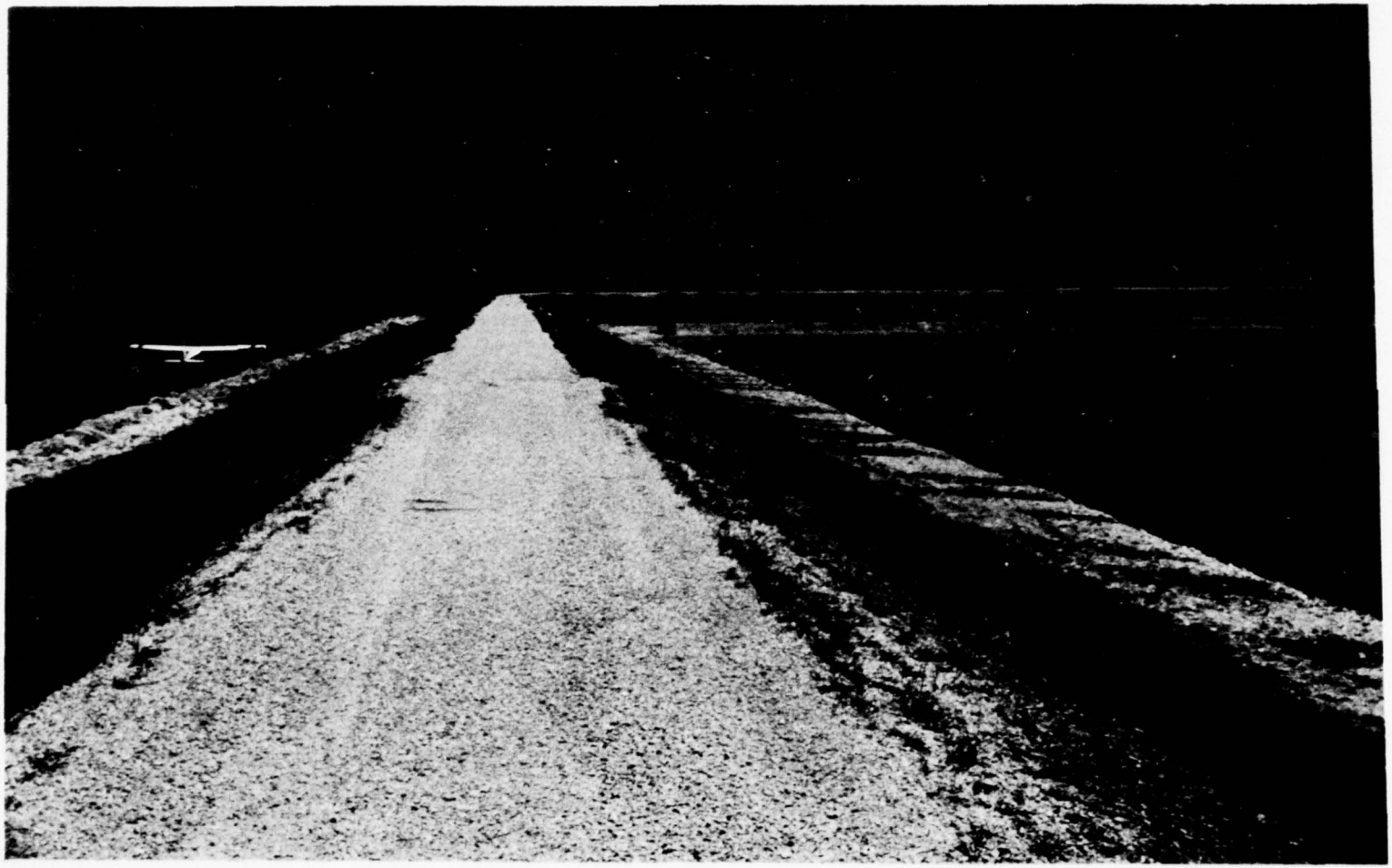


Figure 7. Permanent dike in Toledo Harbor in Lake Erie which serves as nesting substrate for ring-billed gulls, herring gulls, and common terns

and herring gulls. A less obvious retention structure will function similarly to the rest of the site. Cross dikes have the effect of breaking a disposal site into smaller units that can be used to maintain different habitats within the site (Johnson and McGuinness 1975). They may also provide bird nesting area and a surface for shelterbelt plantings (Mann et al. 1975).

b. Configuration. For ease of construction, a confined disposal site usually has a linear dike. Unconfined sites assume the configuration of the topography and are usually not linear. A disposal site with a nonlinear boundary has more aesthetic appeal and blends with the surrounding habitat better than if its boundaries are straight. Since a disposal area has a different structure and appearance from an adjacent area, the junction of the two is considered "edge," a region with characteristics of both. Edges usually have greater diversity and density of wildlife than either of the two single areas (Hamilton and Noble 1975) and are considered desirable management features. A rectangular configuration has more edge (perimeter) than a square one.

c. Elevation and topography. Height of the area in relation to its surroundings is a factor in plant growing conditions and wildlife use. If material is placed too high, the water table may be too low for moisture to reach plant roots. If placed too low, the site may be subject to ponding, runoff from high areas, or waterlogging of the root zone. Topographic variation within the site can be a hindrance to maintenance equipment and could be undesirable on a site that was to be intensively managed. For other purposes of the site, depressions to hold water during the dry season, slopes to direct drainage, regularly placed mounds acting as small islands for nesting, or partitioning dikes for cellular disposal might be beneficial. On large sites, impoundments within an upland substrate offer numerous opportunities for waterfowl management according to techniques in Atlantic Waterfowl Council (1972), Giles (1969), and U. S. Department of Agriculture (1969), and many issues of the Journal of Wildlife Management.

d. Size. There is a correlation between size of a given habitat and its plant and animal composition. In general, as area increases, so do diversity and species numbers. Too small a site cannot provide all the habitat needs of its residents and so inhibits diversity. On too large an area, increased diversity at the expense of a target wildlife species can occur; e.g., by allowing a predatory or competitive species to establish. Researchers have attempted to assign exact size to

different habitat units: McCaffery and Creed (1969) for deer use of forest openings; Thomas et al. (1978) for the average habitat size necessary for maximum species representation; Galli et al. (1976) and Moore and Hooper (1975) for minimal forest island size; Madson (1963) for waterfowl ponds; and Bergman et al. (1977) for minimal home-range requirements of species. Disposal site size can be adjusted in total or internally with cross dikes or topographic relief.

78. Accuracy of the estimates of sediment volume to be dredged can impact project plans. Less material than planned for will limit the size of the habitat. For example, a large extension to Sunken Island in Tampa Bay was planned, but only a small one resulted because of lack of material. Greater volume than expected can fill the site prematurely or to a higher elevation than desired. Burial of undesirable vegetation to prevent its recolonization will not be possible if too little material is placed. Other forms of vegetation control will be needed. However, if excess material is placed, desirable vegetation will be buried and may not be able to colonize the site. Plant propagation may then be required.

79. Two important aspects of timing of disposal are time of year and periodicity. The time of year that dredging takes place can impact rate and success of colonizing or planted vegetation, success of animal reproduction activities, and degree of substrate stabilization. Periodicity of disposal can control succession on the site; regular, frequent disposal maintains a primary stage, and infrequent disposal allows succession to advance between depositions.

80. The importance of relating the site to adjacent habitat is great, since the interaction is strong. A small site may be planned to provide a feeding area for the target wildlife species, but adjacent habitat must be able to provide protection from weather and predators, a water source, and resting area. Conversely, a site managed for ground-nesting birds must be isolated from adjacent habitat occupied by predators. Corridors of travel to adjacent habitats may be necessary to allow full use of the site (MacClintock et al. 1977), or may allow introduction of detrimental species. Other features of this relationship were discussed in paragraph 19.

Placement of vegetation

81. Presence or absence and patterns of vegetation are critical factors in habitat development. Such ecological concepts as structural diversity, community size, species patterns of abundance, biotic succession, and others apply; the reader is referred to both standard (Allee et al. 1949, Odum 1959, 1971) and applied texts (Giles 1969, Leopold 1933, U. S. Department of Agriculture 1969), recent literature, and natural resource journals.

82. Some specific concepts that should be applied to habitat design are discussed briefly below:

a. Diversity. A vegetative community increases in diversity as its complexity increases. Although habitat structure is not the only determinant of animal diversity (Terborgh 1977), in general, greater vegetative diversity leads to greater animal diversity. In the featured species management system, a low-diversity area, e.g. grassland, might be appropriate; in a species richness system, vegetative complexity is preferred, e.g. woodland with tree, shrub, and herb layers. Management practices to decrease diversity consist of some form of vegetative control such as mowing. Diversity can be increased by adding edge, vertical layers, species, or growth forms (Lennartz and Bjugstad 1975), topographic variation (Peterson 1975), or ponds (Reese and Hair 1978).

b. Succession. Vegetative communities change over time in a predictable pattern, and each stage of succession can be characterized by its plant and animal composition. An alteration in the vegetation results in a corresponding change in wildlife communities, which is an important concept in wildlife management. Some wildlife species require one or more specific successional stages, while others are adaptable to a wide range of conditions.

c. Pattern. The pattern of a habitat is a function of juxtaposition and interspersion of vegetation communities and of vegetation and water, ratio of cover types, and density of vegetation. In general, increased detail of pattern leads to increased edge and diversity.

d. Function. The primary functions of vegetation for wildlife are provision of food (seeds, berries, leaves, roots, etc.) and cover. Vegetation structure and pattern are particularly important in the effectiveness of concealment, escape, shelter, nest sites, and resting areas. Both food and cover must be available in appropriate qualities, quantities, and timing for all species.

PART III: CONSTRUCTION

Dredging and Disposal Operations

Construction

83. The first step in construction is to build a protective or retention structure, if called for in the project design, or to modify an existing structure or site (e.g., raise a dike or add drainage). Some site preparation may be necessary, perhaps construction of an access route or removal of vegetation. Access for equipment and pipes should be built to minimize damage, especially to wetlands. Unless the project calls for shallow disposal and recovery of plants present on the site, vegetation to be covered should be mowed or cut to prevent recovery after disposal or to prevent dead branches and shrubs from protruding. Clearing and grading are required along the dike alignment to allow construction.

Dredged material placement

84. A significant amount of material rehandling is sometimes required in developing habitat because the final distribution of material at the site is important. This handling can be reduced if the initial location and distribution of the coarse- and fine-grained fractions of the dredged material are controlled. One means of control is to take advantage of the differential settling characteristics of the various sized particles in the dredged slurry. Another means is to operate the dredging plant and peripheral equipment in a manner that will produce the desired substrate (Bartos 1977b).

85. For the majority of disposal operations, the criteria for locating the discharge pipeline in the disposal area have been to:

a. Maintain an adequate flow distance relative to the weir.

b. Keep the discharge end of the pipeline a safe distance away from the interior slope of the dike.

c. Minimize the pumping distance from the dredge.

These criteria are directed at preventing short-circuiting or channelization of the flow through the containment area, avoiding scouring

damage to dikes, and minimizing pumping costs. Some modifications of these pipe location criteria may be required if advantage is to be taken of particle size differential settling characteristics. For example, it may be possible to position the end of the discharge pipeline at the point of erosion and add coarse material to stop erosion. For a more detailed review of hydraulic pipeline placement criteria, refer to Johnson and McGuinness (1975).

86. Coarse-grained material encountered during dredging operations can be taken advantage of with end-of-pipe operations. If the character of the sediment-water slurry being transported is known beforehand or can be determined by monitoring at the dredge or at the end of the pipe, then the coarse material can be diverted by use of a wye connection without interrupting the dredging operations or the dredging sequence. The diverted material can be placed directly in the desired location hydraulically or stockpiled for later use. Stockpiling and subsequent rehandling of the material is roughly equivalent to obtaining the material from a source outside the disposal area and involves the use of additional or supplementary equipment. Montgomery et al. (1978) provide guidelines on stockpiling and reusing dredged material. Table 13 contains a summary of operational guidelines for placing dredged material in a confined site.

Containment area operation

87. Activities during substrate material placement are aimed at the retention of solids and production of an effluent that will meet criteria for release into the waterway. Operational difficulties, such as channelization of the dredged slurry and insufficient ponding depth, may result in excessive amounts of solids leaving the disposal area through the weir. This is counterproductive and usually violates laws and regulations. Therefore, it is recommended that during and after the disposal operation a well-planned monitoring program be implemented to assure that suspended solids in the effluent remain within acceptable environmental limits. Suspended solids retention can sometimes be increased by increasing ponding depths through efficient operation of the weir.

88. In situations where turbidity or criteria for suspended

solids transport are critical, a floating screen called a silt curtain, which is designed to inhibit the spread of turbidity, can sometimes be effective at reasonable cost. Silt curtains have been successfully deployed around dredging equipment, around unconfined disposal areas, at the effluent exit of confined disposal areas, and within disposal areas to maintain flow circulation paths. They are generally only effective when currents are less than 0.5 knot. Refer to Johanson et al. (1976) for information on the operation and application of silt curtains.

89. The energy available at the discharge end of the hydraulic pipeline is often sufficient to scour and resuspend already deposited material. This energy is easily dissipated, however, by intercepting and redistributing the flow with baffle plates located on the end of the discharge pipe.

90. Activities implemented during disposal are generally oriented more toward maintaining effluent water quality than efficient site management, but a disposal operation can be managed to result in surface topography conducive to surface drainage and rapid precipitation runoff. One technique for achieving this is to place material uniformly throughout the containment area by moving the discharge pipe or working the sediments.

91. Concepts of containment area management instituted immediately following the completion of a disposal operation are also important to successful implementation of a habitat project. Bartos (1977b) concluded that the most important aspect of dredged material disposal area management was to remove all surface water as fast as possible to enhance surface drying. This conclusion can be extended to include terrestrial habitat development, since extensive site activity must usually wait until the substrate is trafficable. See Haliburton (1978) for a summary of research on dewatering dredged material. In addition, working the area to a gentle slope toward the effluent point allows efficient drainage of surface water, and evaporative dewatering can be supplemented by transpiration by vegetation (Lee et al. 1976a).

92. Fine- and coarse-grained materials respond differently to vehicular traffic. Willoughby (1977) found that fine-grained material,

at moisture contents approaching the liquid limit, is remolded by vehicle passage and becomes increasingly weaker relative to the in situ strength of the material. Drainage is not a problem with coarse-grained sediments and they tend to compact under progressive passages of a vehicle. Therefore, vehicles experience little or no difficulty in negotiating coarse-grained material. For a more detailed review of dredged material trafficability studies and equipment available for use in and around disposal areas, refer to Willoughby (1977) and to Green and Rula (1977).

Quality control

93. Specifications for all phases of construction should be detailed and clear. Thorough inspection of all operations will ensure that the work is in compliance with plans and specifications and will mean fewer postdredging operations and lower project cost. Hammer and Blackburn (1977) state that, although specific items to be monitored will vary with the design and method of construction, there are some general items pertinent to all projects:

a. Field personnel should be thoroughly familiar with the plans and specifications for the disposal area and with general aspects of the long-range plans for the area.

b. A meeting should be held between the designer and field personnel to present the designer's views and resolve questions on the operation. The designer should point out any key items that should be observed and any unusual or marginal features anticipated.

c. Field personnel should be thoroughly familiar with the borrow sources and how each type of material will look when being placed or discharged.

d. Field personnel must be provided access to the construction area at all times and should be on hand continuously during construction.

e. Complete written and photographic records of all operations should be maintained.

Substrate Modification

94. Once the dredged material has been placed and dewatered sufficiently to allow equipment access, it can be modified as necessary. Modifications will usually be directed toward preparing the substrate

for vegetation establishment, and will depend on the condition of the substrate and the exact design of the project. In upland habitats, these activities are largely agronomic. Refer to Allen et al. (1978), Clairain et al. (1978), and Hunt et al. (1978) for summaries of such modifications at Dredged Material Research Program field sites and to Coastal Zone Resources Division (1978) for other specific plant species instructions.

Mechanical modification

95. The site may require grading to change the topography that resulted from disposal; e.g., to make the slope uniform by removing depressions or mounds, increase relief by making depressions or mounds or altering the slope, make islands, or raise low spots. Variation in texture of the sediments which results either intentionally by disposal of more than one type of material or naturally through hydraulic sorting during disposal may need to be reduced to a more uniform soil for ease of seedbed preparation. This can be done by repeated passes with a blade or deep plowing followed by disking. If possible, grading should be done at the time of year when precipitation is lowest, to reduce erosion of the bare soil.

96. Seedbed preparation includes plowing or disking one or more times to break up clumps, fill or cover desiccation cracks, even out moisture content, destroy unwanted vegetation that may have invaded, turn under green manure, incorporate chemicals, and in general improve the quality of the substrate. Preparation is best done several months prior to planting and again just before planting, if labor and equipment are available. Success of the site may depend especially on this process.

Chemical modification

97. Prior to final mechanical seedbed preparation (preferably several weeks to months ahead), the substrate at the site should be sampled and the soils analyzed chemically in the same fashion as for site characterization. Their properties may have been altered by dredging and dewatering from what they were in the initial tests. Some of the common problems that may be found include high salinity

levels, soil acidity or alkalinity, or lack of one or more of the essential plant nutrients at levels sufficient to support good plant growth.

98. Substrate salinity may be expected if the sediments are of marine origin or contain salts from irrigation or fertilization. If salinity is present at excessive levels and plant species that are not salt-tolerant are to be planted, then plant establishment will need to be delayed until sufficient leaching or reclamation has occurred to lower the salt content to nontoxic levels. The amount of time required will be a function of the initial salt level in the substrate, amount of precipitation, internal drainage, and particle size of the substrate, since coarser grained material leaches faster than finer grained. It may be a year or more before salinity decreases sufficiently.

99. If high levels of exchangeable sodium (>15 percent of the cation exchange capacity) are present along with the salinity, treatment with gypsum (calcium sulfate) to displace the sodium from the soil exchange complex may be necessary. This is only successful on those substrates with good internal drainage as the sodium sulfate formed in this process is also a soluble salt and must be leached from the soil along with other salts that may be present.

100. High salinity and excess exchangeable sodium require considerable time for correction. Their detection early in the sequence of events will greatly aid in planning future activities at the site.

101. Addition of lime may be necessary to correct soil acidity. The location may have naturally acidic dredged material or, in the case of marine sediments, contain sulfides that upon oxidation change to sulfates and reduce soil pH to as low as 3.0 to 4.0. It is important to remember that soil pH measured on a reduced soil (one that has been water-saturated and oxygen-free for a period of time) will be near neutral and this value will have no relation to the pH of the soil after drying and oxidation have occurred. Also, field conditions can have compounding effects so that a plant that can germinate in laboratory tested soil at pH 4.0 may require 5.0 in the field.

102. The amount of lime needed to increase the soil pH to a suitable level may be significant and will be a function of the initial soil

pH, cation exchange capacity of the soil, the level of sulfides, and the type of plants to be grown. In general, grasses are reasonably tolerant of soil acidity, but legumes grow best at a soil pH of near 7.0. A few legumes, such as the lespedezas, grow well at soil pH levels as low as 5.5. Plant species selection (Part II) will have taken soil acidity into account.

103. Reaction of the liming material with the soil is a function of solubility of the lime. Materials such as calcium oxide and hydroxide are fast acting, whereas calcium carbonate (agricultural limestone) is only slightly soluble, so its reaction time is governed by particle size. If time is limited, use of calcium oxide, calcium hydroxide, or calcium carbonate, all of which will pass a 100-mesh (150-mm openings) screen will, in the presence of adequate soil moisture, react to give a significant increase in soil pH within 3 to 6 weeks. Conventional agricultural limestone will require several months to achieve a significant pH increase; however, because of its distribution of particle sizes, it will have a much longer residual effect in the soil compared to calcium oxide, calcium hydroxide, or finely ground calcium carbonate. In coastal areas, oyster shells may be ground or crushed and broadcast as a source of calcium.

104. Fertilization of the substrate at the site should also be based on soil test analyses. Addition of elements other than those needed creates unnecessary expense and in some cases could result in reduced plant growth. Fertilizer, correctly applied, aids in plant establishment and gives the selected plant species a boost over competitors. Sandy dredged material is usually low in nutrients and the nutrients may be leached from the top layers. Finer grained material normally contains and maintains more nutrients. Figure 8 illustrates plant response to fertilizer applied to sandy dredged material at the Miller Sands field site.

105. Plant species selection will also define nutrient demand. Legumes, if seeds are inoculated and soil pH is favorable, will fix their own nitrogen; however, they are heavy feeders on phosphorus and especially on potassium. Grasses have a high demand for nitrogen and a lesser demand for phosphorus and potassium. When legumes and grasses

Figure 8. Ground view of the Miller Sands field site in the Columbia River, Oregon, showing the positive effects of fertilization on a sandy dredged material substrate in summer 1977. Treated area is to the right

are grown in combination, the legumes may be able to furnish most of the nitrogen needs for the mixture. In this case, fertilization of the mixture with nitrogen will often encourage vigorous growth of the grass at the expense of the legumes.

106. Inorganic fertilizers were found to be easier to apply, more readily available, and cheaper than organic fertilizers on field sites in the Dredged Material Research Program. Plants responded acceptably to inorganic fertilizers.

107. Timing of initial fertilization should be as near to seeding or planting as is feasible since some elements, especially nitrogen, are lost readily from the soil. Care should be taken to ensure that concentrated bands of fertilizer are not located around the roots of recent transplants or around the seeds of direct-seeded plants as most fertilizers are highly soluble salts and could lead to root damage or failure of germination. If a large amount of fertilizer is needed, it is usually best to broadcast and incorporate a portion of it prior to planting or seeding, then topdress the remainder in one or more applications after the plants are well established. Application may be advisable for more than 1 year. Response to fertilization is observed within a short time for grasses and legumes but may take considerably longer to become evident for trees and shrubs.

Biological modification

108. Biological modification of the substrate may also aid in the success of the project. This could include such things as removal of existing and competitive vegetation by cutting, short-lived herbicide application, or cultivation; growth of a preliminary green fertilizer crop; or addition of farmyard manure, sewage sludge, etc., on light-textured sands to improve their nutrient and moisture-holding capacity. If legumes are to be grown on the site, the seed should be inoculated with the proper strain of Rhizombium bacterium to improve chances of fixing adequate amounts of atmospheric nitrogen.

Vegetation Establishment

Timing

109. Timing of all factors related to plant establishment is an important consideration in habitat development. Adequate planning will have allowed lead time to locate, obtain, and prepare sufficient amounts of viable seeds or vegetative propagules, including any period of seed dormancy. Timing of planting will strongly influence plant success. For example, seeding warm weather annuals before the last cool period in spring will result in heavy crop damage, and seeding the same seeds in midsummer will result in heat and drought stress during sprouting. Seeding of cold weather species too early in the autumn will result in sporadic germination, increased chances of insect infestations such as army worms, and heat and drought stress. Optimum seeding times vary with climatic regions, and local agronomic authorities should be consulted before planting. Refer to Tables 5 and 6 for species-specific details on timing and to literature that exists on the various aspects of vegetation establishment (Anderson 1968; Ayres and Scoates 1956; Bernstein 1958; Chandler 1957; Chester 1950; Davis 1957; Edminister and May 1951; Edmond et al. 1963; Gill and Healy 1974; Graetz 1973; Graham 1941; Halls 1973, 1977; Hartman and Kester 1959, 1978; Kadlec and Wentz 1974; Laurie et al. 1958; Lyon et al. 1959; Malcolm 1972; McKell et al. 1972; Meyer et al. 1960; Miller et al. 1959; Neely 1968; Pirone 1959; Robertson 1973; Schwab et al. 1966; Seneca et al. 1977; Smith 1955; Swingle 1939; U. S. Department of Agriculture 1953, 1955, 1957, 1961, 1972; Wolfe and Kipps 1959; and Woodhouse et al. 1976).

Planting operations

110. General. Vegetative propagules may be planted any time the ground is not frozen and any time the day temperatures average less than 20°C. In general, March to May is best for warm weather plants and September to November for cold weather plants over most of the United States. In the Deep South, transplanting is usually done successfully from October through May, with June through September being too hot. Dormant propagules may be more readily transplanted in winter

months. Propagules held in storage inside a nursery or greenhouse should not be planted until temperatures at the field site are at least as warm as the storage area, to lessen shock. Propagules held in a shady area should be gradually acclimated to sunny conditions if the site is in the sun, to prevent blistering and death of leaves and plant shock. General planting methods are given below; specific recommendations for local conditions can be obtained from the Soil Conservation Service or county extension service agents.

111. Methods. Methods of planting vary with the propagule type. Seeds should be sowed in a well-prepared seedbed that has been plowed and/or disked to a depth of at least 15 cm.

a. Techniques. Mechanical seeding is faster, more efficient, and cheaper than hand seeding, but site conditions will dictate which technique should be used. Seeds may be broadcast by a one-man hand-whirled seed thrower or sowed in rows and covered with soil by hand. Seeds may be drilled in rows with a mechanical tractor-operated planter which will cover the seeds in the same planting operation.

b. Rates. Seeding rate per hectare varies with each species. Small-seeded species such as some grasses require only 1.5 to 7.5 kg/ha of seeds compared to larger seeded species such as soybeans or corn that require 60 to 90 kg/ha.

c. Depths. Small-seeded species are usually planted at a depth of 2 cm or less, compared to 2- to 5-cm depths for larger seeded species.

d. Treatments. Preemergence or postemergence herbicide applications may be necessary to inhibit competing species. Mechanical cultivation or hoeing of rows is advisable to control weeds and aerate the seedbed, although broadcast seeds cannot be cultivated. Fertilizer and/or lime, if necessary, should be applied at the time of seeding as a broadcast top dressing or mixed in with the soil during seedbed preparation. On slopes subject to erosion such as dikes, mulching of the seedbed is necessary until the plant root systems are well enough established to hold the soil. Burlap bags fastened to the soil with nails or pegs, wooden strips laid horizontally to the slope, or strips of sod planted horizontally will prevent slope erosion.

112. For transplanting vegetative propagules, a weed-free loose

soil is adequate, but the better prepared the soil is, the greater the probability of success.

a. Techniques. A mechanical planter combined with hand labor to feed propagules into a hopper is commonly used. Propagule size and type are limited by this method, however. Hand labor must be used for many propagules, especially trees and shrubs over 30 cm high, since they will not fit in the machine. Propagule types should be handled in the following manner:

(1) Root stock may be planted either immediately after being dug or after holding in a nursery or greenhouse. In the former case, the root stock should be planted as soon as the top shoots are removed from the propagule. A hole should be dug that is twice as deep and twice as wide as the propagule, then filled back with loose soil or mulch to a depth that allows the crown, or base of the top shoots, to be above the soil level. Place the root stock on the loose material in the center of the hole, and pull loose soil back to fill the hole two thirds full, leaving a circular depression around the propagule with the base of the top shoots left above soil. Apply fertilizer and/or lime as needed around but not on the propagule in the depression, then cover it with another layer of soil. Fill the depression with water to completely saturate the soil and remove air pockets around the roots. Leave a depression to hold water as the plant grows, and extra soil may be mounded to form a shallow dike around the plant. This will not keep the plant too wet unless there is a prolonged rainy period resulting in continuous saturated soils and flooding. If irrigation becomes necessary to keep the plants alive, then only the depression needs to be filled with water, reducing time and water needed.

(2) Rhizomes should be planted either individually or in shallow trenches no more than 5 cm deep. If roots are attached to the rhizomes, plant so that the roots are as deep as necessary to prevent crowding, always keeping the rhizome itself in the top 5 cm. The base of the top shoots should be above the soil level. This may make the rhizome itself actually at the top of the soil, which is acceptable and even necessary for some species. Fertilize and/or lime the rhizomes as needed, then cover the fertilizer with the soil. Water well to remove air pockets.

(3) Tubers are treated similarly to seeds and sowed on a site if small or planted in rows if large. Mechanical equipment should probably not be used, since tubers should be kept moist and are not as easily handled as dry material. Plant them 3 to 7 cm deep, cover with soil, and fertilize as for seeds.

(4) Cuttings may be handled three ways. If the cutting is to be planted immediately, dip the end of the cutting in rooting hormone, push it into loose soil to a depth one half to two thirds the length of the cutting, and water it well. If the cutting has been made earlier and has been stored in a cold room so that no roots have formed, it should be soaked in warm water for 24 hours prior to being dipped in rooting hormone and placed in the soil. A new cut made above the old one to expose new tissue before adding rooting hormone will be beneficial. If no rooting hormone is used, do not make a new cut. If the cutting was held in a soil bed or pot at room temperatures and was allowed to form roots, then it should be handled as a seedling.

(5) Seedlings and rooted cuttings are preferably transplanted to the soil bed intact, without being removed from the pot. The same techniques for root stock apply for seedlings. If the seedling must be planted without the pot, or if it is transplanted directly from the source to site, then every effort should be made to minimize root system disturbance by leaving as much soil as possible around the roots.

(6) Transplants are handled similarly to root stock and seedlings, but are larger and more difficult to work with. They also should be planted with the root system undisturbed; and, in general, the larger the transplant, the more critical the need for planting it in a biodegradable pot, balled and burlapped, or at least with a ball of soil around its root system to minimize shock. Commercial sources offer greater chances for success, since nursery plant root systems are pruned to induce most of the feeder roots to grow within a small circle around each plant. When the plant is dug and replanted at the field site, a minimum of shock and stress occurs because the root system is essentially intact.

b. Rates and spacing. Several factors cause planting rates and spacing to vary:

(1) Vegetation form. In general, the following spacings will give good cover in 2 to 3 years:

Vegetation Form	Planting Centers, m
Vines	1.0
Grasses	
Clumps	0.2
Stolons	0.5
Herbs	0.5
Small shrubs (to 1.8 m)	0.7
Large shrubs (to 6.0 m)	2.0
Small trees (to 9.0 m)	2.0
Large trees (to 24.0 m)	7.0

(2) Rate of establishment. If cover is needed for stabilization in a year, distance between centers should be reduced. Larger spacings can be used if a delay in complete cover is acceptable.

(3) Time of planting. Larger distances between centers are feasible when planting is done at the beginning of the growing season, since rapid new growth will compensate for the spacing. Plantings done at mid-season or the end of the growing season should be on closer spacings.

(4) Propagule types. Trees and shrub propagules should by spaced as in subparagraph (1) above, regardless of the propagule. Unrooted cuttings of other plants will have a poor survival rate and grow slower than the other propagule types, so spacing should be adjusted to allow for a 50 percent death rate. Root stocks and rhizomes grow slower than the other vegetative propagules, so spacing will need tightening by one third for like cover. Tubers sowed like seeds should be spaced 7 to 10 cm apart as they will produce large plants rather quickly, compared to seeds.

(5) Project goal. This factor pertains primarily to shrubs and trees. If the goal is nesting habitat for colonial waterbirds, wider spacing between large shrubs and trees is desirable than that listed in (1). Plant large shrubs and small trees on 4-m centers and large trees on 10- to 15-m centers. This will allow spreading of branches and foliage and provide more nesting habitat as the plants develop. This will also provide shade and more of a parklike effect among the trees.

PART IV: MAINTENANCE AND MANAGEMENT

Monitoring

Purpose

113. To ensure the project objective is being met, some degree of observation of the site during and after its construction is necessary. This will help locate and avert potential problems and deviations from the intended direction. The level of attention needed will be greatest in the initial stages (e.g., monitoring the disposal process, overseeing propagule collection and planting) and will in most cases decrease with time. The need for observation will depend on such factors as future plans for the site, funds available for management, the desire to estimate the progress of the site toward equilibrium with the surrounding area, and the need to document technical aspects of the site's construction and function for guidance on other projects.

114. Monitoring of the substrate and protective or retention structure should show changes in topography, such as erosion channels or breaches. Soil monitoring should document changes in soil conditions that affect plant growth or animal use, such as loss of nutrients or change of substrate surface. Vegetation growth should be related to its intended function on the site, wildlife should be monitored for its response to the vegetation and overall site characteristics, and both should be used to indicate undesirable situations such as colonization of pest species.

Procedures

115. For each item to be monitored, four steps should be followed (Hamilton 1978):

a. Develop a statement of objectives.

b. Identify the population or unit to be sampled and data to be collected.

c. Specify the precision of data collection.

d. Select an efficient sampling design.

116. Photographs. Regularly scheduled air photography can be

used to great advantage to record both general and specific progress of the site. Taken at the same scale and from the same vantage point, comparisons over time can show substrate movement, soil development, pattern and degree of vegetation development, and stability of engineering structures. Black-and-white film will show contrast and pattern of the site, and infrared film will show major vegetative characteristics.

117. Flying services can be obtained from private contractors and individuals, local airports, and some state or Federal agencies. The Earth Resources Observation Systems (EROS) Data Center, administered by the U. S. Department of the Interior Geological Survey, applies remote sensing to natural resources management and may have useful coverage. Contact User Services, EROS Data Center, Sioux Falls, South Dakota 57198, for information. In general, flights over a site should be taken at times with less than 20 percent cloud cover. Altitudes of 350 to 500 m are suitable for general coverage and of 170 m for more specific purposes and closer observations. Consider flying time and tide levels if the site's perimeter is subject to tidal flooding, since flood and ebb will alter the appearance of the site.

118. Ground-based photography is also useful. Use the same vantage point for sequential shots, and include a landmark for reference in subsequent photos to make changes evident. A mosaic of the site can be made with panoramic shots.

119. Soil and plant analyses. If the site is to be managed for optimum plant growth, then soil samples should be taken each spring and routine analyses performed for those variables such as pH, salinity, and availability of major nutrients that may have been of concern during initial phases of the project. These soil samples can usually be taken from the 0- to 15-cm surface layer of soil, as this is where most plants have their feeder roots. Also, if the site contains areas of poor plant growth that cannot be explained by topography or other visual evidence, it may be advantageous to take soil and plant tissue samples from the abnormal area and an adjacent area of normal plant growth. Analysis and comparison of these samples for nutrients, soil pH, and salinity and correlation with plant response may clarify why poor growth is occurring and

suggest a remedy. A basic soil fertility text by Tisdale and Nelson (1966) may be of value in understanding soil and plant relationships, as may sections of Chapman (1976).

120. Monitoring of the substrate for progress toward equilibrium with the surrounding area should consist of yearly sampling of the site and a selected reference area or areas. These samples should consist of the 0- to 15-cm and 15- to 40-cm soil layers; if funds are limited, the top layer is adequate. Samples should be frozen in the field, transported to the laboratory, and analyzed for such items as organic matter, cation exchange capacity, available macronutrients, pH, salinity, ammonia, nitrate, total Kjeldahl nitrogen, and particle size. Those items most likely to show change with time are pH, salinity, organic matter, and nutrient availability, so their analysis should be emphasized if funds are limited.

121. Vegetation sampling. Visual observation may be sufficient to show the condition of the plants. Look for overall vigor, chlorotic tissue, abnormal growth, crowding and stunting, disease or insect infestation, and wildlife damage (trampling, grazing, browse lines, etc.). More substantial observations will require use of sampling methods (see Part II). It may be appropriate to use habitat evaluation procedures (U. S. Department of the Interior 1976a) or some modification of those methods (Lines and Perry 1978, and Whitaker et al. 1978). Methods in the literature range from the specific (Harlow 1977) to the general (James and Shugart 1970). A good general reference is Chapman (1976).

122. Documentation of wildlife use. Monitoring of wildlife use can be by simple observation of sign, an extensive censusing program, or a program intermediate in complexity. Consider observation of tracks in sand or dirt; browse and graze signs; trails, runways, burrows, or beds; or droppings (Murie 1954). A more active monitoring program might include trapping sessions, searches for nests and young, or regular periods of observation; e.g., breeding bird surveys or diurnal counts. Both the wildlife species and the type of use should be identified.

123. The literature on sampling methods is too extensive for discussion here. A representative listing includes Anderson et al. (1976), Bond (1957), Caughley (1977), Gentry et al. (1974), Giles (1969), Kendeigh (1944), Marion and Shamis (1977), and Neff (1968).

Maintenance and Management of the Site

Structure repair

124. A break in a protective or retention structure will cause a variable degree of impact, depending on the condition of the site and the timing. If a protective structure slowly erodes as the site stabilizes, the site may be capable of self-protection by the time the structure is gone. If a break occurs during a storm, however, significant damage to the site can occur. Decisions on repair will have to be made from an onsite evaluation.

Structure removal

125. Design of the project may include eventual removal of a structure, either by natural processes or direct action. For example, after the site dewatered, the sand dike at the Nott Island field site was graded into substrate and planted with the rest of the site (Hunt et al. 1978). A structure may be designed with a short life, as at Nott Island, or with the intention of it being breached, as recommended by Parnell et al. (1978) and Soots and Landin (1978) to allow young seabirds hatched on the site to reach the water.

Erosion control

126. Erosion on the site's interior will rarely be desirable and should be controlled, primarily by stabilizing the substrate with vegetation. External erosion of a protective or retention structure should be prevented, unless the structure is planned to be temporary. A number of methods are described by Hammer and Blackburn (1977) for structure protection, including vegetation establishment, placement of polyethylene sheeting, riprap, or gabions, and deposition of a flat sandy beach.

Maintenance and Management of Vegetation

127. The difference between maintaining and managing vegetation is one of degree, with maintenance being a form of low-level management. The degree of effort of management required depends on answers to the following questions:

a. What was the project goal?

b. What was the intended level and timing of management in the project design?

c. How suitable was the plant species selection? Did the plants grow satisfactorily?

d. Are the quantity and quality of established vegetation adequate in relation to the project design?

e. Have any disruptions occurred, such as detrimental wildlife or human use, storm damage, further deposition of dredged material, or fire?

128. Soil treatment is a basic management practice and may involve:

a. Fertilization. Comparison of the nutrient needs of the plant species and analysis of recently taken soil samples will govern fertilizer application. Normally, fertilizers should be applied in the spring when most of the plants on the site resume growth. If large amounts of nitrogen are needed, especially on coarse sands or poorly drained sites, split applications spaced throughout the growing season will be beneficial in reducing nitrogen losses from either leaching or denitrification.

b. Liming. Most soils in humid regions become acid with time as excess precipitation removes elements such as calcium and magnesium from the soil exchange complex. Also, if the dredged material contained sulfides, these may continue to be oxidized to sulfates and lower the soil pH. In both cases, lime should be added when soil tests indicate the substrate is becoming too acid to support the type of vegetation growing on the site. The amount of additional lime will be a function of the cation exchange capacity of the soil, the percent hydrogen saturation of the cation exchange capacity, the desired soil pH, and the quality and fineness of grind of the limestone used.

c. Cultivation. Cultivation of some type will probably be necessary for new plantings to survive and make adequate growth. The main purpose of cultivation is to control unwanted vegetation, but an additional benefit on some soils may be an increase in porosity of the surface soil

allowing increased water penetration. Method of cultivation will depend on spacing of the plantings, accessibility of the site to mechanized equipment, and type of weed competition. On sites that are largely inaccessible to tractors, cultivation may be with selective herbicides that can be applied with hand-held equipment and directed only to those areas and plants whose control is desired. If mechanical cultivation is used around trees and shrubs, it should be less than 12 cm deep to minimize damage to their roots. An alternative method of controlling unwanted vegetation around young trees and shrubs is mowing. Mowing has the advantage of allowing a ground cover of plants to minimize soil erosion on slopes, but the disadvantage, especially in drought conditions, of allowing weedy plants to continue to compete with the plantings for moisture.

129. Vegetation manipulations and management can be accomplished in several ways. Timing of the manipulations is largely specific to the situation and is an essential consideration. For example, mowing should be timed to avoid cutting cover needed by ground-nesting birds; burning too late in the spring may kill some desirable plants.

a. Mowing or cutting. Cutting invading species will reduce competition with planted species. Some planted species such as grasses may be mowed to induce them to spread by vegetative means rather than by seeding; vegetative propagation gives denser cover faster and uses less of the plant's energy than seeding.

b. Grazing. Herbivores may induce vegetative growth in a similar fashion as mowing.

c. Burning. A controlled burn may be used to remove dead plant material and stimulate new growth.

d. Staking. Until root systems are well established, some shrubs and trees may require staking to prevent lodging.

e. Pruning. Planted species may require pruning to reach the shape best suited to their intended use.

f. Weeding or thinning. Selective cutting to prevent shading or crowding or too dense a stand may benefit the plantings.

g. Herbicide application.

130. Additional plantings might be done to replace unsuccessful propagules, expand the habitat in size, alter the site by adding new vegetation, or institute another phase. An example of the latter would

be an initial planting of grasses on a sandy site to stabilize it and start accumulating organic matter, and a secondary planting of shrubs to increase structural diversity.

131. A common management practice is to set back vegetative succession through disturbance such as fire or cutting. Deposition of dredged material on a site can serve the same purpose. This is recommended in Soots and Landin (1978) and illustrated with a management scheme to maintain varying substrate cover, including bare ground, through recurring disposal.

132. Protection of individual plants or of the site may be necessary. Young trees may have to be wrapped to prevent rodents and rabbits from eating their bark or equipment from cutting them. It was necessary to fence the habitat development site in Texas (Allen et al. 1978) to keep rabbits and feral goats from destroying the plantings and to trap a large population of nutria at the site in Oregon (Clairain et al. 1978) to prevent excessive grazing.

133. Infestations of diseases and insects may reach levels that require some control measures. Fungi, smuts, viruses, and bacteria can be controlled by cutting and burning diseased plants or by applying appropriate pesticides (Chester 1950). Noinfectious diseases (sun scald, frost injury, and salt injury) should be treated as they occur. Chewing, burrowing, or disease-carrying insects may be controlled biologically (releasing predators) or chemically (applying insecticides).

PART V: COSTS

134. The cost of a habitat development project is specific to the type of project, the level of effort to be expended, and the location. This discussion is primarily intended as a checklist of items to consider when working up a budget.

Planning

135. Planning costs may be partially covered by nonproject funds, but cost of several items should be considered:

a. Site selection (maps, air photos, travel, coordination meetings, preliminary testing).

b. Site characterization (maps, aerial reconnaissance, air photos, travel, purchase of pertinent literature, labor, supplies and equipment, laboratory testing, pilot field test, consultant fee).

c. Coordination (meetings, documents, travel).

Construction, Maintenance, and Management

136. In any dredging project, a detailed cost analysis and evaluation are prepared. Some of the factors itemized below are more thoroughly discussed in Palermo and Zeigler (1977):

a. Disposal site capital costs.

b. Operation and maintenance costs.

c. Dredged material transportation costs.

d. Future site reclamation, development, or maintenance costs.

e. Value analysis on estimated annual and future costs and benefits.

137. For comparative analyses for habitat development, cost estimates and other economic considerations should only include expenses incurred in construction of the habitat, since dredging costs will accrue in any case. Habitat construction expenses include such items as

engineering and design costs, dike construction, elevation and landscaping activities (Palermo and Zeigler 1976, 1977), peripheral fence construction, substrate modification, and vegetation establishment. These costs should be weighed against the cost of providing a containment area for disposal of dredged material if it were not used for habitat development. Containment area construction costs for a typical location in the United States in July 1977 are given in Eckert et al. (1978).

138. Substrate modification costs will normally consist of grading and disking to prepare a seedbed. Grading by custom operator with a motor grader or bulldozer may cost $30.00 to $75.00/hr of operating time, depending on the size of equipment. Disking for seedbed preparation should cost approximately $11.00 to $31.50/ha per single trip over the site. Proper seedbed preparation will require multiple disking, so budgeting should allow for at least three trips. These prices do not include costs for transporting equipment to the site.

139. Soil treatment will most often consist of fertilization and possibly liming. Costs of materials vary from one area to another. The following are best estimates of 1978 costs and do not include transportation to the site or application at the site:

a. Nitrogen: $0.20 per pound of N.

b. Phosphate: $0.15 per pound of P_2O_5.

c. Potash: $0.09 per pound of K_2O.

Lime sells for $6.00 to $8.00/ton. If delivery and spreading are included, the price is $10.00 to $15.00/ton on a site accessible to large spreader trucks. Lime may be available from the state agricultural agency for the cost of transport.

140. Table 14 contains estimated man-hours for collecting, handling, and planting vegetation. It is based on actual operating time and does not include transportation, facilities, equipment rental, etc. Labor is assumed to be semitrained. Commercial operations with adequately trained personnel should be conducted in less time. Note that propagule type, rate of planting, and spacing of planting will affect costs. Detailed costs on the Miller Sands habitat development field site in Oregon are found in Ternyik (1978).

Monitoring

141. Field inspections and sampling will have to be costed on a specific basis and include labor, supplies, and transportation. Supplemental inspection by aerial survey has the following general costs:

a. Small fixed-wing aircraft and pilot time can be rented for $25.00 to $40.00/hr. A more economical daily rate may be available.

b. Helicopters usually rent for $200 to $300/hr. This rate is higher than that of fixed-wing aircraft, but mobility is greater and may make the inspection more efficient overall. An additional advantage is the ability to land on the site.

c. Aerial photography costs vary with the quality of coverage desired. Mapping-quality photographs taken by a professional firm can be obtained for less than $2000, including air time, film, and processing. Lower quality photographs taken with a hand-held camera by a nonprofessional are suitable for at least interim records of the site. Calculate costs by including labor, aircraft rental, pilot time, film, processing, and camera equipment.

PART VI: POTENTIAL PROBLEMS

142. The planner should be aware of regulations, problems, or delays that may surface during some phase of the project. Many potential problems can be averted with additional coordination or preventative action such as public hearings, discussions with special interest groups, or meetings with local officials and agency representatives.

Constraints

143. Reports on productive uses of dredged material besides habitat development provide a good review of constraints the planner might find (Gushue and Kreutziger 1977, SCS Engineers 1977, Skjei 1976).

Legal

144. A number of Federal laws such as the 1969 National Environmental Policy Act, 1972 Federal Water Pollution Control Act Amendments, and 1973 Endangered Species Act apply to dredging and disposal and therefore to most habitat development projects. A summary of these laws is found in U. S. Department of the Interior (1976b). Appropriate Corps of Engineers regulations should be consulted.

145. State and local laws may include zoning regulations, lists of protected species, or restrictions on collection or propagation of certain plant species. Critical Habitat designation may affect activities at the site. Project authorization may not include authority or funds for habitat development. Obtaining permission to deposit dredged material and to use access routes may be difficult and time-consuming.

Social or political

146. Definition of local needs in order to set a project goal may be clouded by special interest groups or apathy. Local needs, desires, and land use may exclude habitat development as a means of dredged material disposal. Two categories of objections to confined disposal areas in general were identified by Harrison and Chisholm (1974): effectiveness of the site (dike erosion, ponding, etc.) and biological/chemical/physical factors (odor, lack of aesthetics, etc.).

Economic

147. Lack of authorization for habitat development within the overall project may mean a lack of funds. If a funding base exists, it may be inadequate, unpredictable, or restricted in some fashion.

Human factors

148. Location of and ease of access to the site will determine the amount of pressure or stress put on the site by people. Disposal sites often serve as recreation areas, with the possible association of fires, litter, trampled vegetation, soil compaction, and wildlife disturbance. Human access may have to be controlled in some locations or at critical times of the year.

Project Timing

149. Timing of operations must correspond with the biological calendar of growing seasons and breeding seasons, which requires scheduling to get all planning, construction, and planting activities accomplished. Planning must inclued adequate lead time for obtaining propagules, either propagule collection or growing, or seed harvesting and breaking of dormancy. Disposal in later summer will have minimum impact on breeding populations of most wildlife; weather at that time offers acceptable working conditions, and the possibility of the site being ready to plant the following spring is maximized. Soots and Landin (1978) list the breeding periods of colonial waterbirds that nest on dredged material islands, during which time disposal may be detrimental. Planting a site in spring or early fall will usually correspond with optimum growing conditions, giving the highest probability of success of vegetation establishment.

Contaminants

150. In certain areas of the United States, such as near certain industries or extensive agriculture, pollution is an important factor to be considered. If the dredged material contains contaminants, it may have to be placed in a confined site.

151. Planning for habitat development on contaminated material should consider the following factors:

a. Amounts and types of contaminants in the material, possibly to include heavy metals, fertilizers, sewer wastes, pesticides, or petroleum products.

b. Maximum acceptable levels for pollutants in water and in soils, plants, and animals, as set by the Environmental Protection Agency.

c. Kinds of plants and animals that will be on the site, their abilities to regulate uptake of these pollutants, and their tolerance levels before life efficiency is reduced, reproduction ceases, or death occurs.

d. Chances of biomagnification via the food chain from plants, invertebrates, and microbes to animals on the site or to humans.

e. Impact of contaminants on the site and surrounding areas.

152. Lee et al. (1976b, 1978) and other studies have shown that plants absorb heavy metals in varying degrees depending upon the species. These contaminants in most cases are not translocated to a large extent into the top shoots but are retained primarily in the root systems. Potential danger is limited to users of the root systems, such as waterfowl that feed on plant tubers. However, preliminary research on marsh plants grown in upland areas indicates a tendency to accumulate heavy metals (Personal Communication, C. R. Lee, Soil Scientist, August 1978, Environmental Laboratory, Waterways Experiment Station, Vicksburg, Miss.).

153. Many pesticides, chemical by-products, and petroleum products have unknown biomagnification abilities. It is known that some pesticides have affected reproductive abilities of birds by causing eggshell thinning and behavior modification. Petroleum products can smother small organisms (potential food items). Fertilizers and sewer wastes alter the habitats where they accumulate by changing plant growth habits and species composition and by reducing dissolved oxygen levels in water, which affects the food supply of fish-eating animals.

154. See Patrick (1978) for treatment of the contaminant problem. The problem can be avoided on upland habitat development sites by:

a. Stabilizing the areas with plant species known to not transport contaminants into their top shoots.

b. Avoiding management for wildlife grazing to reduce danger of a biomagnification problem.

c. Managing for wildlife that will not feed on the site, such as fish-eating birds that use the site for nesting and roosting purposes only. A good example of this is the Toledo Harbor, Ohio, disposal site in Lake Erie that is being filled over a 20- to 30-year period with contaminated dredged material. Common terns, ring-billed gulls, and herring gulls are nesting inside the dikes but do not feed there since they are all fish-eating species (Figure 7).

Invasion of Undesirable Plant Species

155. Invasion of unwanted plants is frequently a problem, especially on existing sites where plant propagules for colonization of new dredged material already are present. Invading species may result in a habitat that is unsuitable for the target wildlife species. The most frequent invader in the east and gulf coast areas with the exception of south Florida and Texas is common reed, an aggressive, adaptable, and persistent species. Two species that readily colonize dredged material, dog fennel and broom sedge, are agronomic pests and considered weeds. All three species have some wildlife value: common reed is used as nesting material and nest sites by some songbirds and migratory waterbirds; dog fennel and broom sedge are used as cover and for visual isolation by laughing gulls nesting from Florida to North Carolina.

Pests and Disease

156. Two types of vertebrate pests may require control measures:

a. Predators. Predators known to be a problem on habitat development sites include Norway rats, cotton rats, common crows, and snakes. Their greatest impact is destruction of eggs and nestlings of waterfowl and ground-nesting waterbirds.

b. Grazers and browsers. Rodents, rabbits, nutria, cattle, goats, deer, and geese can destroy newly planted or invaded vegetation and hold back succession of established vegetation. Feeding pressure may, however, be light

enough to not permanently damage the plants but induce them to spread vegetatively or increase in yield of seed (Clark and Jarvis 1978). Grazing pressure also varies with the region. For example, Canada geese destroyed many plantings at the Windmill Point habitat development site (Lunz et al. 1978b) but not at the Miller Sands site (Crawford and Edwards 1978).

157. Recommended control methods include fencing the site to exclude pests, trapping and removing the pests, locating the site at a sufficient distance from a source to discourage colonization of pests, and planning the project goal so it does not coincide with a known predator problem.

158. Infestations of harmful invertebrates such as chewing insects will be an occasional problem and should be dealt with, if necessary, as they occur.

159. Smuts, fungi, bacteria, blights, rots, and viruses all occur among plants but tend to infect only weakened individuals. The best method of control is prevention, by selecting healthy propagules and treating and planting them in the appropriate manner. If diseased plants are found on a site, the problem is remedied in one of three ways. If the plant is already severely weakened and dying, cut it down and burn it to kill the disease organisms. If a mild infection is apparent, identify the disease and treat with the appropriate control spray, or cut off the dead and infected material and burn it.

160. Control measures instituted for any pests or diseases should fit the design of the project. No control may be the most compatible approach.

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Table 1

Importance of Selected Soil Analyses

Particle size. Particle size governs such factors as moisture-holding capacity, supply of nutrients, internal drainage, and trafficability. Coarse-grained sediments have good internal drainage; however, their capacity to hold moisture and supply nutrients is limited. Fine-grained sediments tend to restrict water movement and may limit mobility on the site.

Available nutrients. Availability of nutrients, especially nitrogen, phosphorus, and potassium, determines plant growth and fertilizer requirements. Tests for micronutrients are not as reliable as those for macronutrients, but they may indicate a potential problem. Since *there is no relation between total nutrient* level in the soil and availability of that nutrient to plants, the analysis should be for available levels of nutrients.

pH. An indication of the soil's basic or acidic condition is given by pH tests. Most agricultural soils have a pH between 5.0 and 8.0. Soils with a pH outside this range are likely to inhibit normal plant growth. Most plant species have an optimum pH level for best growth and perform poorly at higher or lower levels; e.g. legumes in general do best between 6.0 and 7.0 (Wolfe and Kipps 1959). Also, soil pH governs the solubility of a number of heavy metals, which may be present at either deficient or toxic levels, depending on soil pH. Sulfide levels in sediments that were dredged from areas under saltwater influence may be important. When material with a high sulfide content is placed on land and dewatered, the sulfides oxidize to sulfates and acidify the soil, often reducing the pH to below 4.0.

Salinity. Plant species have varying tolerances to soil salinity. While excess soil salinity is not readily or rapidly decreased, knowledge of salinity levels allows one to choose plants that tolerate high salinity or to decide to delay establishment of the site until sufficient natural leaching has occurred to reduce salinity to a suitable level for normal plant growth.

Organic matter. Organic matter content consists of plant tops, roots, bacteria, fungi, protozoa, remains of living organisms, and other organic factions in various stages of decay. It influences such soil properties as cation exchange capacity, tilth, moisture-holding capacity, and levels of available nutrients.

Contaminants. If potential contaminants such as heavy metals, pesticides, or hydrocarbons are suspected to be present, and especially if the soil particle size is small and if soil acidity has already been identified as a problem, analyze for the suspected contaminant. Synergistic effects of metals and acidity are potentially detrimental to vegetation establishment.

Table 2

Laboratory Testing of Coarse-Grained Noncohesive Soils*

Test	Purpose	Scope of Testing
Visual classification	Visually classify the soil in accordance with the Unified Soil Classification System	All samples
Gradation	Determine grain-size distribution for classification and correlation with permeability and/or shear strength parameters	Representative samples of foundation and borrow materials for dikes
Relative density or compaction	Determine minimum-maximum density values or maximum density and optimum water content values	Representative samples of all borrow materials for dikes. Use the test which gives greatest values of maximum density
Consolidation	Provide parameters necessary for settlement analysis	Not generally required as pervious soils consolidate rapidly under load and post-construction magnitude is usually insignificant
Permeability	Provide parameters necessary for seepage analysis	Not usually performed as correlations with grain size are normally of sufficient accuracy
Shear strength	Provide parameters necessary for stability analysis	Representative samples of compacted borrow and foundation soils. Consolidated drained strengths from direct shear or triaxial tests are appropriate for free-draining pervious soils Conservative shear strength values can usually be assumed based on test results from similar soils

* Modified from Hammer and Blackburn (1977).

Table 3

Laboratory Testing of Fine-Grained Cohesive Soils*

Test	Purpose	Scope of Testing
Visual classification	Visually classify the soil in accordance with the Unified Soil Classification System	All samples
Water content	Determine the water content of the soil in order to better define soil profiles, variation with depth, and behavioral characteristics	All samples
Atterberg limits	Foundation soils: for classification, comparison with natural water contents, or correlation with shear or consolidation parameters Borrow soils: for classification, comparison with natural water contents, or correlations with optimum water content and maximum dry densities	Representative samples of foundation and borrow soils. Sufficient samples should be tested to develop a good profile with depth
Compaction	Establish maximum dry density and optimum water content	Representative samples of all borrow soils for compacted or semicompacted dikes: Compacted: perform standard 25-blow test Semicompacted: perform 15-blow test
Consolidation	Determine parameters necessary to estimate settlement of dike and/or foundation and time-rate of settlement. Also, to determine whether soils are normally consolidated and to aid in estimating strength gain with time	Representative samples of compacted borrow where consolidation of dike embankment itself is expected to be significant Representative samples of foundation soils where such soils are anticipated to be compressible Samples of fine-grained adjacent and/or underlying materials at structure locations
Permeability	Estimate the perviousness of borrow and/or foundation soils and so calculate seepage losses and time-rate of settlement	Generally not required for fine-grained cohesive soils as such soils can be assumed to be essentially impervious in seepage analyses. Can be computed from consolidation tests
Shear strength	Provide information for retention structure design Pocket penetrometer, miniature vane, unconfined compression, and triaxial tests to determine unconsolidated-undrained strengths and consolidated-undrained strengths. Direct shear tests to determine consolidated-drained strengths as appropriate	Pocket penetrometer and miniature vane (Torvane for rough estimates) Unconfined compression tests on saturated foundation clays without joints, fissures, or slickensides Appropriate triaxial and direct shear tests on representative samples of both foundation and compacted borrow soils for dikes

* Modified from Hammer and Blackburn (1977).

Table 4

Addresses of U. S. Fish and Wildlife Service Regional Endangered Species Coordinators, by Region and State

Region	State(s) Included	Coordinator's Address
Alaska Area	Alaska	Endangered Species Coordinator U. S. Fish and Wildlife Service 813 D Street Anchorage, AK 99501
1	Washington, Oregon, Idaho, California, Nevada, Hawaii	Endangered Species Coordinator U. S. Fish and Wildlife Service Lloyd 500 Building 500 N.E. Multnomah Street Portland, OR 97232
2	Arizona, New Mexico, Texas, Oklahoma	Endangered Species Coordinator U. S. Fish and Wildlife Service Federal Building, U. S. Post Office and Courthouse 500 Gold Avenue, S.W. P. O. Box 1306 Albuquerque, NM 87103
3	Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio	Endangered Species Coordinator U. S. Fish and Wildlife Service Federal Building, Fort Snelling Twin Cities, MN 55111
4	Kentucky, Arkansas, Tennessee, North Carolina, Louisiana, Mississippi, Alabama, Georgia, South Carolina, Florida, Puerto Rico and Virgin Islands	Endangered Species Coordinator U. S. Fish and Wildlife Service 17 Executive Park Drive, N.E. P. O. Box 95067 Atlanta, GA 30329
5	Maine, New Hampshire, Vermont, Massashusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, Virginia	Endangered Species Coordinator U. S. Fish and Wildlife Service One Gateway Center Newton Corners, MA 02158
6	Montana, North Dakota, South Dakota, Wyoming, Nebraska, Iowa, Utah, Colorado, Kansas, Missouri	Endangered Species Coordinator U. S. Fish and Wildlife Service 10597 W. Sixth Avenue P. O. Box 25486 Denver Federal Center Denver, CO 80225

Table 5

Selected Upland Plant Species for Habitat Development on Dredged Material Sites*

Species** (Alphabetized by Common Name)	Best Propagule Type	Collection Periods†	Temporary Storage Requirements	Planting Periods	Range††	Mature Height	Growth Habits	Remarks
Grasses								
American beachgrass (Ammophila brevilliguiata)[1,2,3]	Transplants	Oct-March	In wet sand beds or in pots of sand	Feb-May	MA, NE, GL	To 1.5 m	Perennial cool season grass with stiff stems, full sun	Tolerates saline conditions, beach and dune areas, excellent for sandy beach and dune areas
American dunegrass (Elymus mollis)[1,3]	Transplants	Sept-March	In wet sand beds or in pots of sand	March-June	NE, PNW	To 1.5 m	Strong, erect, fast growing, full sun	Prefers sandy areas, good soil stabilizer
Bahia grass (Paspalum notatum)[1,3]	Seeds	July-Sept	Dry, cool area	March-June	SE, MA, FL, MS	To 0.5 m	Summer perennial, creeping base with upright stems, full sun	Cultivated for pasture, good cover, wide range of soils
Barley (Hordeum vulgare)[1,2,3]	Seeds	May-July	Dry, cool area	Oct-Nov	Entire U. S.	To 1.3 m	Annual, winter cover crop grass, full sun	Extensively cultivated for cover and grain, requires good soil bed
Barnyard grass (Echinochloa crusgalli)[1,3]	Seeds	June-Sept	Dry, cool area	May-Sept	Entire U. S. except FL	To 2 m	Annual grass, arching heads, full sun	Prefers moist soils, cultivated for waterfowl food
Beach panic grass (Panicum amarum)[1]	Transplants	Sept-March	In wet sand beds or in pots of sand	March-June	MA, SE, FL, MS	To 1.3 m	Perennial, few flowered, full sun	Prefers sandy soils
Beaked panic grass (Panicum anceps)[1]	Seeds	July-Sept	Dry, cool area	April-June	MA, SE, FL, MS, MRV, SP, MP	To 2 m	Perennial, hardy, fast growing, full sun	Prefers moist sandy soil
Big bluestem (Andropogon gerardi)[1,3]	Seeds	July-Sept	Dry, cool area	April-June	Entire U. S. except PNW, CA	To 2 m	Perennial, robust, tufted, dense sod, full sun	Important forage grass, prefers well-drained soils
Bromegrass (Bromus inermus)[1,3]	Seeds	July-Sept	Dry, cool area	April-June	Entire U. S. except SE, FL, MS, SP	To 2 m	Perennial, creeping rhizomes, erect stems, dense sod, full sun	Important forage grass, prefers well-drained soils
Broomsedge (Andropogon virginicus)[1]	Seeds	Sept-Oct	Dry, cool area	May-Sept	Entire eastern U. S. and CA	To 1 m	Perennial, dense culm, upright stems, full sun	Pest plant in pastures and crops, grows under most soil conditions
Browntop millet (Panicum ramosum)[3]	Seeds	Sept-Nov	Dry, cool area	March-July	SE, MA, MS, FL	To 0.6 m	Summer annual, erect stems, good seed producer, full sun	Prefers wet soils, excellent waterfowl food, no soil preparation necessary in many cases
Bull Paspalum (Paspalum boscianum)[1]	Seeds	July-Oct	Dry, cold room	March-June	MA, SE, FL, MS	To 2 m	Stout summer annual, fast growing, spreading, full sun	Prefers moist soils, good seed producer
Bushy beardgrass (Andropogon glomeratus)[1]	Seeds	Aug-Oct	Dry, cool area	April-June	NE, MA, SE, FL, MS, SP, SW, CA	To 2 m	Erect, dense, fast growing, full sun	Prefers moist soils
Callie Bermuda grass (Cynodon dactylon hybrid)[3]	Transplants, root stock	Year-round	In soil beds	March-June	SE, MS, SP, FL	To 0.5 m	Perennial, fast growing, sterile, full sun	Vigorous new hybrid Bermuda, pasture use

(Continued)

* Sources of these data are from unpublished data by the author and Britton and Brown (1970), Brockman (1968), Correll and Johnston (1970), CZRD (1978), Franklin and Cyrneas (1973), Halls (1977), Harrar and Harrar (1962), Hartman and Kester (1959, 1975), Hitchcock (1950), Hitchcock and Cronquist (1973), Hotchkiss (1967), Long and Lakela (1971), Oefinger and Halls (1974), Radford et al. (1973), Rehder (1960), Sargent (1922), Thompson and Thompson (1974), and Wolfe and Kipps (1959).

** Numbers given after species names indicate the following information:
1-Known to occur on dredged material.
2-Planted on dredged material sites.
3-Known to be available commercially or from State and Federal nurseries.

* Collection periods, storage requirements and planting periods are only for best propagules. Many of these species may be handled in other ways for other propagule types not portrayed in this table.

†† SE = southeast; MS = midsouth; SP = south plains; MP = mid plains; NP = north plains; NE = northeast; MA = mid Atlantic; PNW = Pacific northwest; SW = southwest; FL = Florida; GL = Great Lakes; MRV = Mississippi River Valley; CA = California; MW = midwest.

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Grasses (Continued)								
Coastal Bermuda grass (*Cynodon dactylon* hybrid)[3]	Transplants, root stock	Year-round	In soil beds	March-June	SE, MA, FL, SP, MS	To 0.5 m	Perennial, fast growing, sterile, full sun	Planted extensively in southern pastures for grazing and hay, tolerates salt spray
Common Bermuda grass (*Cynodon dactylon*)[1,3]	Seeds	June-Sept	Dry, cool area	April-June	Entire U. S. except MW, PNW, NP, NE	To 0.2 m	Perennial, fast growing, abundant seeds, full sun	Pasture crop, lawns, pest in cultivated areas, tolerates wide range of conditions
Common reed (*Phragmites australis*)[1]	Root stock, rhizomes	Sept-March	In sand beds or pots of sand	Feb-June	GL, NE, MA, SE, FL, MS, SP	To 4 m	Perennial, fast growing, persistent, full sun	Pest plant in many areas, not recommended for any use other than soil stabilization
Corn (*Zea mays*)[1,2,3]	Seeds	July-Oct	Dry, cool area	March-June	Entire U. S.	To 3 m	Summer annual, upright, heavy seed producer, full sun	Cultivated extensively for grain, silage, and human consumption
Dallis grass (*Paspalum dilatum*)[1,3]	Seeds	June-Sept	Dry, cool area	Year-round (MS, FL) April-May (north)	SE, MS, FL, MA, SP, SW	To 1.5 m	Dense perennial, full sun	Cultivated pasture grass
Deertongue (*Muhlenbergia rigens*)[1]	Seeds	Aug-Oct	Dry, cool area	Oct-Nov; March-Apr	NE, MA, SE, MS, MP, NP, MRV	To 1.6 m	Warm season, full sun, dense clumps	Tolerates acid soils, seeds have strong dormancy
European beachgrass (*Ammophila arenaria*)[1,3]	Transplants	Oct-March	Hold in wet sand beds or in sand pots	Feb-May	PNW, CA	To 1.5 m	Perennial, cool season grass, rigid stems, full sun	Tolerates saline conditions, excellent for sandy beach and dune areas
Fall panic grass (*Panicum dichotomiflorum*)[1]	Seeds	Sept-Nov	Dry, cool area	Feb-June	Entire U. S. NP, PNW	To 1 m	Coarse, summer annual, fast growing, good seed producer, full sun	Tolerates wide range of soil conditions including wet areas, considered crop pest
Foxtail millet (*Setaria italica*)[3]	Seeds	June-Sept	Dry, cool area	April-July	Entire U. S. except MW, FL, SP	To 2 m	Summer annual, upright, fast growth, full sun	Cultivated extensively for grain and silage, prefers moist soils
Goose grass (*Elcusine indica*)[1]	Seeds	June-Sept	Dry, cool area	April-July	Entire U. S. except NP, PNW	To 0.5 m	Small culmed perennial, heavy seed producer, full sun	Pest plant in cultivated areas, grows in most soil conditions
Green bristlegrass (*Setaria viridis*)[1]	Seeds	July-Oct	Dry, cool area	April-July	Entire U. S.	To 1 m	Vigorous summer annual, clumped, full sun	Occurs in many soils, pest in crops, not palatable to browsers
Italian ryegrass (*Lolium multiflorum*)[1]	Seeds	May-July	Dry, cool area	Oct-Nov	Eastern U. S. and SP, NP, PNW, CA	To 1 m	Perennial in south, annual in north, hardy, forms dense root system, full sun	Cultivated for winter grazing, quick winter cover, and lawns
Japanese millet (*Echinochloa crusgalli* hybrid)[3]	Seeds	June-Sept	Dry, cool area	April-Sept	Entire U. S. except FL	To 1.5 m	Tall heavy annual, abundant seeds, full sun	Occurs in all soils, grown for waterfowl and cattle feed, is salt tolerant to some extent
Johnson grass (*Sorghum halepense*)[1,3]	Seeds	July-Oct	Dry, cool area	April-Sept	Entire U. S. except NP, MW, PNW	To 1.5 m	Hardy, fast growing, erect, strong seed producer, full sun	Planted for pastures and hay, pest in cultivated areas
Jungle rice (*Echinochloa colonum*)[1]	Seeds	June-Sept	Dry, cool area	May-Sept	Entire U. S. except NP, MW	To 0.4 m	Perennial, prostrate to erect, full sun	Good seed producer, prefers wet to moist soils

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Grasses (Continued)								
Large crabgrass (*Digitaria sanguinalis*)[1]	Seeds	June-Sept	Dry, cool area	April-Sept	Entire U. S. except NP	To 0.3 m	Creeping annual, fast growing, full sun	Occurs in all soils, pest in cultivated areas, immune to herbicides
Little hairgrass (*Aira praecox*)[1]	Seeds	June-Aug	Dry, cool area	April-June	MA, PNW, CA	To 0.2 m	Annual, tufted culms, full sun	Prefers sandy, dry coastal soils
Oats (*Avena sativa*)[3]	Seeds	May-June	Dry, cool area	Sept-Oct	Entire U. S.	To 1 m	Cool season annual, agronomic cereal crop, full sun	Occurs in almost all soil conditions, needs well-prepared seed bed
Orchardgrass (*Dactylis glomerata*)[1,3]	Seeds	June-Aug	Dry, cool area	Mar-Sept	Entire U. S.	To 1.3 m	Clumped, perennial, hardy, full sun to shade	Prefers well-drained soils and does well in many soils, cultivated for grazing, hay, and silage
Panic grass (*Panicum clandestinum*)[1]	Seeds	June-Aug	Dry, cool area	Mar-June	Eastern and mid-U. S.	To 1.3 m	Dense clumped perennials, strong rhizomes, full sun	Prefers moist sandy soil
Pearl millet (*Pennisetum glaucum*)[3]	Seeds	Sept-Oct	Dry, cool area	Mar-June	MA, SE, SP, SW	To 2 m	Robust, summer annual, heavy seed producer, full sun	Cultivated for grain and silage, prefers moist soil but tolerates drought
Perennial ryegrass (*Lolium perenne*)[1,3]	Seeds	May-July	Dry, cool area	Sept-Nov	SE, MS, SP, TL	To 1 m	Hardy, dense root system, full sun	Good winter cover, good winter wildlife food and cattle forage in the south
Prairie cordgrass (*Spartina pectinata*)[1,2,3]	Seeds	July-Oct	Dry, cool area	Apr-June	Entire U. S. except SE, FL, MS, CA	To 3 m	Tall perennial, full sun	Occurs in wet, coastal areas
Proso millet (*Panicum miliaceum*)[3]	Seeds	Sept-Oct	Dry, cool area	Mar-June	MW, SP	To 1.3 m	Summer annual, erect stems, full sun	Produces seeds in 4 months after planting, good food value, cultivated for grain
Quackgrass (*Agropyron repens*)[1]	Root stock	Sep-Mar	In sand beds or pots of sand	Mar-June	Entire U. S.	To 1.3 m	Perennial, long running root stock, hardy, full sun	Pest plant, exotic
Red fescue (*Festuca rubra*)[1,3]	Seeds	May-Aug (north)	Dry, cool area	Mar-May (north)	Entire U. S. except FL, SP, MS, SE	To 1 m	Hardy robust creeping grass forms a dense sod, shade to full sun	Cultivated extensively in mixed stands for pastures, lawns, and rights-of-ways
Redtop (*Agrostis alba*)[1,3]	Seeds	Aug-Oct	Dry, cool area	Apr-June	Entire U. S.	To 1 m	Tall hardy, stoloniferous, full sun	Cultivated for silage, hay, and grazing
Reed canary grass (*Phalaris arundinacea*)[1,3]	Seeds	Jun-Aug	Dry, cool area	Mar-June	Entire U. S.	To 2 m	Summer perennial, robust, fast growth, full sun	Prefers moist soil, but grows anywhere, cultivated on sewage areas and for pastures, good seed producer
Rescue grass (*Bromus catharticus*)[1,3]	Seeds	Jul-Oct	Dry, cool area	Apr-June	SE, MA, CA, SW	To 1 m	Robust, summer perennial, full sun	Cultivated in south as forage
Rice cutgrass (*Leersia oryzoides*)[1]	Seeds	Aug-Oct	Dry, cool area	Apr-Jul	Entire U. S.	To 1.3 m	Dense culms, perennial, much branched, shade to full sun	Prefers moist and wet soils
Rye (*Secale cereale*)[3]	Seeds	May-Jul	Dry, cool area	Sep-Nov (south) Apr-May (north)	Entire U. S.	To 1 m	Hardy cool season annual, high seed producer, full sun	Cultivated extensively for grain, cover, and green forage crops, especially in north

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Grasses (Continued)								
Saltgrass (Distichlis spicata)[1,2,3]	Transplants, seeds	Sep-May Jul-Sep	In sand beds or in pots of sand	Mar-June	Entire U. S. in saline areas except PNW, CA	To 0.3 m	Dense perennial, hardy, many rhizomes, good seed producer, full sun	Prefers moist, coastal areas, occurs in salt marshes and on sand dunes
Saltmeadow cordgrass (Spartina patens)[1,2,3]	Transplants, seedlings	Year-round (south) Mar-Oct (north)	In wet sand beds or in sand pots	Feb-Jun	NE, MA, SE, FL, MS, SP	To 1 m	Densely rooted, summer perennial, spreads best from tillers	Occurs in flooded saline areas to dry sand dunes, occurs frequently, and is successfully planted on dredged material
Sand dropseed (Sporobolus cryptandrus)[1]	Seeds	Sep-Oct	Dry, cool area	Apr-Jul	Entire U. S.	To 1 m	Erect perennial, hardy, slow growing, full sun	Prefers sandy soils, grows on prairie areas
Sea oats (Uniola paniculata)[1,2,3]	Transplants, seeds	Sep-Mar (trans) Jul-Oct (seeds)	In wet sand beds dry, cool area	Mar-June	MA, SE, FL, MS	To 2 m	Robust perennial, dense roots, full sun	Prefers sandy, coastal areas, excellent dune stabilizer, tolerates salt spray
Seashore bluegrass (Poa macantha)[1]	Transplants	Sep-Mar	In wet sand beds or pots of sand	Mar-June	PNW, CA	To 0.4 m	Creeping rhizomous perennial with upright culms, full sun	Prefers coastal sand dunes
Seashore paspalum (Paspalum vaginatum)[1]	Transplants	Sept-Mar	In wet sand beds or in sand pots	Sep-June	SE, FL, MS	To 0.4 m	Dense perennial, fast growing, full sun	Tolerates flooding and salt spray, occurs on dredged material islands in dense stands
Shoredune panic grass (Panicum amarulum)[1]	Seeds	Sept-Oct	Dry, cool area	Mar-May	NE, MA, FL, MS, SP	To 2 m	Upright, coarse, perennial, fast growing, full sun	Prefers sandy beach soils, tolerates salt sprays, occurs on dredged material islands
Sixweeks fescue (Festuca octoflora)[3]	Seeds	May-June	Dry, cool area	Mar-May	Entire U. S.	To 0.3 m	Annual, fast seed producer, full sun or shade	Cultivated as forage and hay crops
Smooth crabgrass (Digitaria ischaemum)[1]	Seeds	Jun-Sept	Dry, cool area	Apr-Sept	Entire U. S. except SW	To 0.3 m	Creeping, fast growing, annual, full sun	Occurs in many soil types, a pest in cultivated fields and gardens
Sorghum (Sorghum vulgare)[3]	Seeds	July-Oct	Dry, cool area	Apr-Sept	Entire U. S.	To 1.5 m	Upright, summer annual, heavy seed producer, full sun	Cultivated extensively as grain and silage crop, tolerates wide range of soils
Sudan grass (Sorghum sudanese)[3]	Seeds	July-Oct	Dry, cool area	Apr-July	Entire U. S. except NP, NE, PNW	To 3 m	Wandering, upright, annual, hardy, fast growing, full sun	Cultivated for hay and silage, tolerates wide range of soils
Switchgrass (Panicum virgatum)[1,3]	Seeds	June-Sept	Dry, cool area	Apr-Sept	Entire U. S. except NP, PNW, CA	To 2 m	Summer perennial, fast growing, hardy, full sun	Prefers moist soils, grows at water's edge, tolerant of salt spray
Tall fescue (Festuca arundinacea)[1,2,3]	Seeds	Apr-June (south) May-Aug (north)	Dry, cool area	Oct-Nov (S) Mar-May (N)	Eastern U. S. except FL, MP, PNW	To 1.5 m	Cool weather grass in south, summer grass in north, full sun	Cultivated for pastures
Texas millet (Panicum texanum)	Seeds	Jul-Oct	Dry, cool area	Mar-Aug	MA, SE, FL, MS, SP	To 2 m	Summer annual with spreading stems, full sun	Fast growing, considered crop weed, grows well on sand dunes
Timothy (Phleum pratense)[1,2,3]	Seeds	Jul-Sept	Dry, cool area	Apr-June	Entire U. S. except SP, FL, MS	To 1 m	Summer perennial, fast growing, erect, full sun	Cultivated extensively in north for hay

(Continued)

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UPLAND HABITAT DEVELOPMENT WITH DREDGED MATERIAL: ENGINEERING A--ETC(U)
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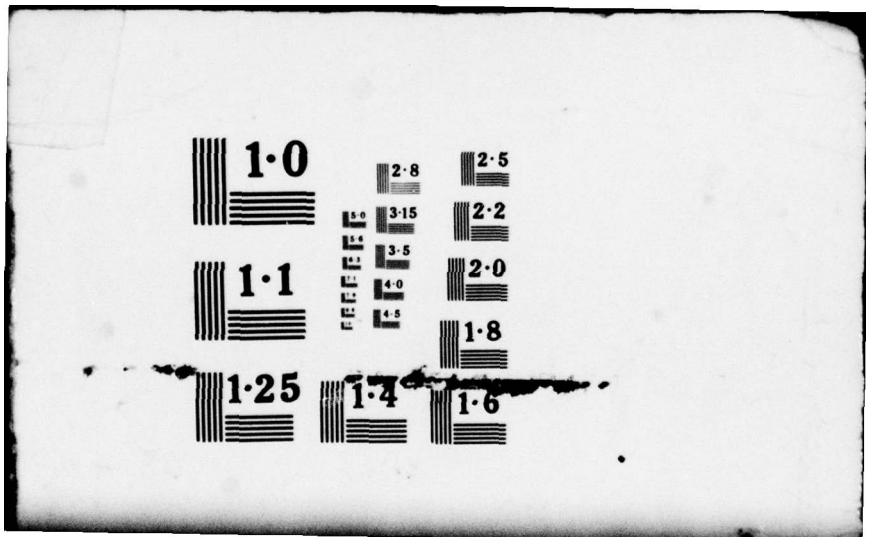
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Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Grasses (Continued)								
Torpedo grass (Panicum repens)[1]	Transplants	Sep-Mar	In wet soil beds or pots of sand	Sept-June	FL, MS, SP	To 0.1 m	Stout perennials, many rhizomes, dense cover, full sun	Sea beaches, prefers sandy moist soils, tolerates salt spray
Vasey grass (Paspalum urvillei)[1]	Seeds	July-Sept	Dry, cool area	Apr-June	FL, SE, MA, MS, SP, CA	To 2 m	Clumped, stout perennial, erect, hardy, full sun	Prefers moist soil, pasture grass, roadside cover
Virginia dropseed (Sporobolus virginicus)[1]	Seeds	Jun-Sept	Dry, cool area	Apr-June	MA, FL, MS	To 0.4 m	Perennial, branching rhizomes, erect culms, full sun	Occurs on sandy and muddy seashores, tolerates salt spray
Walter's millet (Echinochloa walteri)[1,3]	Seeds	July-Sept	Dry, cool area	April-Sept	SP, MS, FL, SE, MA, NE, GL	To 3 m	Stiff stems, abundant seeds, annual, full sun	Occurs in all soils, cultivated for waterfowl food, prefers wet soils
Wheat (Triticum aestivum)[3]	Seeds	May-July	Dry, cool area	Oct-Nov (winter) Mar-May (spring)	Entire U. S.	To 1 m	Winter annual, good seed producer, hardy, full sun	Cultivated extensively, tolerates cold, good cover and food crop
Wild rye (Elymus virginicus)[1]	Seeds	May-July	Dry, cool area	Sept-June	Entire U. S. except CA	To 1.2 m	Perennial, tufted erect culms heavy seeds, full sun	Prefers moist soils, good seed producer, tolerates salt spray somewhat
Wooly panic grass (Panicum lanuginosum)[1]	Seeds	July-Sept	Dry, cool area	April-June	MA, SE, FL, MS	To 0.7 m	Perennial, clumped, spreading shade and sun	Prefers moist soils, grows in woods and open areas, occurs on sea coast
Yellow bristlegrass (Setaria lutescens)	Seeds	July-Oct	Dry, cool area	April-July	Entire U. S. except SW, CA	To 1 m	Summer annual, good seed producer, full sun	Occurs in many soil conditions, pest in crops, not palatable to browsers
Herbs								
Alfalfa (Medicago sativa)[3]	Seeds (inoculated)	July-Sept	Dry, cool area	Aug-Sept or Feb-April	Entire U. S.	To 0.5 m	Perennial, much-branched legume, full sun	Requires good seedbed preparation, occurs on most soils, prefers rich, moist areas
Alsike clover (Trifolium hybridum)[1,3]	Seeds (inoculated)	Mar-Apr (south) June-Sept (north)	Dry, cool area	Nov-Feb (south) Mar-Jun (north)	Entire U. S.	To 0.5 m	Perennial, ascending branches full sun	Prefers moist, acidic soils, cultivated in areas other clays won't grow
Arrow-leafed tearthumb (Polygonum sagittatum)	Transplants, seeds	July-Sept	Dry, cool area	Mar-June	Eastern and mid-U. S.	To 0.6 m	Viney, annual, weak stemmed, spiney, full sun	Prefers moist soils
Beach pea (Lathyrus japonicus)[1]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-June	Entire coastal U. S.	To 0.3 m	Perennial viney plant, hardy, full sun	Prefers sandy moist soils, occurs on coastal beaches, dunes, and islands
Beach strawberry (Fragaria chiloensis)	Transplants	Sept-Mar	In sand beds or in pots of sand	Mar-June	PNW, SW	To 0.2 m	Perennial plants with runners full sun to shade	Prefers moist sandy soils
Big filaree (Erodium botrys)	Seeds	Apr-July	Dry, cool area	Sept-Nov	CA	To 0.2 m	Winter annual, full sun	Pest plant, occurs in most well-drained soils
Bird's foot trefoil (Lotus corniculatus)[1]	Seeds (inoculated)	June-Sept	Dry, cool area	Mar-June	NE, MA	To 0.6 m	Long rooted perennial, full sun	Pest plant, occurs in most soils, common on coasts
Bittersweet nightshade (Solanum dulcamara)[1]	Seeds	May-Sept	Dry, cool area	April-May	NE, MA, NJ	To 2.6 m	Perennial, climbing stem, full sun to shade	Prefers moist soils and in woods, but grows in open areas
Black medic (Medicago lupulina)[1,3]	Seeds (inoculated)	Mar-June (south) June-Aug (north)	Dry, cool area	Nov-Feb (south) Mar-Jun (north)	Entire U. S.	To 0.3 m	Annual, shallow taproot, full sun	Prefers well-drained or dry soils, dormant in south in the summer

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Black nightshade (Solanum nigrum)[1]	Seeds	July-Oct	Dry, cool area	Apr-Jun	Eastern U. S.	To 1 m	Erect, annual, hairy, hardy, full sun	Pest in cultivated areas, occurs in most soils
Blackseed plantain (Plantago rugelii)[1]	Seeds	June-Sept	Dry, cool area	Apr-Jun	Eastern and mid U. S.	To 1 m	Perennial, rootstock stout, thick, erect, hardy, full sun or shade	Pest plant, occurs in woods, fields, and waste areas
Bottlebrush (Plantago arenaria)[1]	Seeds	May-Oct	Dry, cool area	Apr-Jun	Eastern U. S.	To 1 m	Annual, many branched stem, full sun	Prefers well-drained open areas
Bracted plantain (Plantago aristata)[1]	Seeds	Jun-Oct	Dry, cool area	Apr-Jun	Entire U. S. except MW, PNW, CA, SW	To 0.5 m	Perennial, stout root-stock, erect, full sun	Prefers dry open areas
Broadleaf plantain (Plantago major)[1]	Seeds	May-Sept	Dry, cool area	Apr-June	Entire U. S.	To 0.2 m	Perennial, rootstock, short, thick, erect, full sun	Occurs in most soils, in waste places
Buckthorn plantain (Plantago lanceolata)[1]	Seeds	Apr-Nov	Dry, cool area	Mar-June	Eastern U. S.	To 0.3 m	Perennial, pubescent, short rootstock, full sun	In fields and waste places
Bush lupine (Lupinus arboreus)	Seeds	June-Sept	Dry, cool area soak in hot H_2O before planting	Apr-June	PNW, CA	To 0.6 m	Perennial, many branched, shrubby, full sun	In dry, open areas
Calandrinia (Calandrinia maritima)	Seeds	July-Sept	Dry, cool area	Mar-June	CA	--	--	In dry scrub areas, sandy coastal beaches
Camphorweed (Heterotheca subaxillaris)[1]	Seeds	July-Sept	Dry, cool area	Apr-June	MA, SE, FL, MS, SW, SP, MP	To 1 m	Biennial, many branched, many flowered, full sun	Prefers dry, sandy soils, sea beaches, occurs commonly on dredged material islands
Chufa (Cyperus esculentus)[1,2,3]	Tubers, seeds	July-Oct	Moist cold room (tubers) Dry, cool area (seeds)	Mar-June	Entire U. S.	To 0.6 m	Perennial sedge, robust, fast growing, numerous edible tubers full sun	Prefers wet to moist soils, prime wildlife food, extremely prolific
Coast deervetch (Lotus formosissimus)	Seeds (inoculated)	June-Sept	Dry, cool area	Apr-June	PNW, CA	To 0.5 m	Perennial, long roots, slender stems, full sun	Prefers dry, well-drained soils
Common chickweed (Stellaria media)[1]	Seeds	Dec-Feb	Dry, cool area	Oct-Dec	Entire U. S.	To 0.5 m	Weak, tufted annual, much branched, full sun	Pest plant in all agronomic situations
Common filaree (Erodium cicutarium)[1]	Seeds	Apr-July	Dry, cool area	Sept-Nov	NE, MA, SE, SP, GL, PNW, CA	To 0.2 m	Winter annual, taproots, many branched, full sun	Pest plant, occurs in most soils, prefers well-drained soils
Common lambsquarters (Chenopodium album)[1]	Seeds	July-Oct	Dry, cool area	April-June	Entire U. S.	To 1.3 m	Annual, erect, bushy common, shade to full sun	Pest plant, occurs in most soils, occurs on dredged material islands
Common mullein (Verbascum thapsus)[1]	Seeds	June-Sept	Dry, cool area	April-June	Entire U. S.	To 2.3 m	Erect, stout, biennial, full sun	Pest plant, occurs in open well-drained areas
Common purslane (Portulaca oleracea)[1]	Seeds	June-Sept	Dry, cool area	April-June	Entire U. S.	To 0.2 m	Annual, prostrate, free branching, deep roots, full sun	Prefers dry sandy areas
Common ragweed (Ambrosia artimisiifolia)[1]	Seeds	Sept-Nov	Dry, cool area	April-June	Entire U. S.	To 2.3 m	Annual, shallow roots, robust, common, full sun	Pest plant, occurs in most soils, tolerates salt spray, occurs on dredged material islands
Common spikerush (Eleocharis palustris)[1]	Transplants, seeds	April-Sept	In sand beds (trans.) moist, cool area	April-Sept	Entire U. S.	To 1 m	Perennial, upright, slender stems, full sun	Occurs in moist soils in interior areas

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Common threesquare (Scirpus americanus)[1]	Transplants, seeds	Sept-Mar (trans) July-Oct (seeds)	In sand beds (trans.) moist cool area	Mar-June	Entire U. S. except SW	To 2 m	Perennial, upright, triangular stems, full sun	Occurs in moist soils in fresh and brackish areas, good wildlife food
Cow pea (Vigna sinensis)[1,3]	Seeds (inoculated)	June-Sept	Dry, cool area	Mar-Sept	Entire U. S.	To 0.5 m	Summer annual, viney, fast growing, good seed producer, full sun	Cultivated in most soils for human food, hay and forage, especially in the south
Crimson clover (Trifolium incarnatum)[3]	Seeds (inoculated)	Mar-Apr (south) June-Sept (north)	Dry, cool area	Dec-Feb (south) Mar-Jul (north)	Entire U. S.	To 0.5 m	Strong perennial in south, annual in north, procumbent stems, fast growing	Cultivated on most soils for hay and grazing, and on rights-of-ways
Croton (Croton californicus)	Seeds	Aug-Oct	Dry, cool area	Apr-June	CA, SW	To 1 m	Many branched, stout annual, robust, full sun	Occurs in waste areas and dry soils, pest plant
Curly dock (Rumex crispus)[1]	Seeds	Apr-July	Dry, cool area	Apr-June	Entire U. S.	To 1.3 m	Perennial, stout, deep tap root, erect, persistent, full sun	Pest plant, occurs in waste areas and crops and in most soils
Deerweed (Lotus scoparius)	Seeds	June-Sept	Dry, cool area	April-June	CA	To 0.5 m	Perennial, long tap roots, full sun	Occurs waste areas, dry soils
Dwarf spikerush (Eleocharis parvula)[1]	Transplants, seeds	Mar-Nov (trans) June-Sept (seeds)	In sand beds dry, cool area	Mar-June	Entire U. S. except SW	To 1 m	Perennial, tiny stems, turf-like, full sun	Occurs in moist soils in fresh, brackish areas
Filaree (Erodium obtusiplicatum)	Seeds	April-Sept	Dry, cool area	Nov-May	PNW, CA	To 0.3 m	Annual, tufted, ascending stems, full sun	Occurs in most soils, waste places and fields, prefers well-drained areas
Flat pea (Lathyrus sylvestris)[1,3]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-June	NE, MA, MBV, GL, PNW	To 2.3 m	Perennial, viney plant, forms mats, full sun to shade	Occurs in most soils, very slow growing
Flowering spurge (Euphorbia corollata)[1]	Seeds	April-Oct	Dry, cool area	Mar-June	Eastern and mid U. S.	To 1 m	Perennial, long stout rootstock, erect, full sun	Prefers dry soils
Giant ragweed (Ambrosia trifida)[1]	Seeds	July-Oct	Dry, cool area	Apr-June	Entire U. S. except PNW, CA	To 0.5 m	Annual, stout, erect, persistent, full sun	Pest plant, prefers moist soil, tolerates salt spray, common on coasts
Goosefoot (Chenopodium murale)[1]	Seeds	June-Sept	Dry, cool area	Mar-June	Entire U. S.	To 1 m	Annual, scruffy, erect, branched, full sun	Pest plant, occurs in most soils, in waste places
Hardstem bulrush (Scirpus acutus)[1,2]	Rhizomes, transplants	June-Sept	Dry, cool area	Mar-June	Entire U. S.	To 2 m	Perennial, stout, sharp stemtips, persistent, full sun	Prefers moist soils, pest in low ground pastures, extremely hardy
Hairy vetch (Vicia hirsuta)[3]	Seeds (inoculated)	Mar-Apr (south) Apr-Jul (north)	Dry, cool area	Nov-Feb (south) Mar-May (north	Entire U. S.	To 1 m	Annual or biennial, viney, weak stemmed, fast growing, full sun	Cultivated for forage, occurs in most soils, excellent erosion control
Hemp sesbania (Sesbania exaltata)[1]	Seeds	Aug-Nov	Dry, cool area	Mar-June	SW, MA, SE, FL, MS, SP	To 4 m	Annual legume, widely branched, robust, full sun	Occurs in most soils, pest in soybean fields
Hop clover (Trifolium procumbens)[3]	Seeds (inoculated)	Jan-Mar (south) Mar-Jun (north)	Dry, cool area	Oct-Feb (south) Jan-Apr (north)	Entire U. S.	To 0.3 m	Winter annual, low, forms carpet, procumbent, full sun	Occurs on poor dry soils, excellent nitrogen fixing legume, crowds out grasses
Horse nettle (Solanum carolinense)[1]	Seeds	May-Sept	Remove pulpy coat dry, cool area	Apr-June	Eastern U. S. and SP	To 1.3 m	Perennial, erect, spiny, branched, full sun	Occurs in most dry soils, pest plant in agricultural situations

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Horseweed (Erigeron canadensis)[1]	Seeds	June-Nov	Dry, cool area	Apr-June	Entire U. S.	To 3.3 m	Annual, stout, erect, fast growing full sun	Pest plant, occurs on most soils, tolerates salt spray, common on dredged material islands
Japanese clover (Lespedeza striata)[3]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-April	Entire U. S.	To 1 m	Annual, erect, many branched, full sun	Cultivated for forage, and silage, excellent on poor well-drained soils
Jerusalem artichoke (Helianthus tuberosus)	Seeds	Sept-Oct	Dry, cool area	Apr-June	Eastern U. S. mid-U. S.	To 4 m	Perennial, fleshy, root-stock, tubers, stout, erect	Prefers moist soil, tubers are edible
Korean clover (Lespedeza stipulacea)[1]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-Apr	Entire U. S.	To 1 m	Annual, erect, many branched, full sun	Cultivated for forage, hay, and silage, excellent on poor well-drained soils
Ladino clover (Trifolium repens var. latum)[3]	Seeds (inoculated)	Mar-Apr (south) Apr-Jul (north)	Dry, cool area	Nov-Jan (south) Feb-Mar (north)	Entire U. S.	To 1 m	Perennial, fast growing, fleshy stems, creeping, full sun	Cultivated for forage, hay, and silage, excellent on poor, well-drained soils
Ladysthumb (Polygonum persicaria)[1]	Seeds	June-Oct	Dry, cool area	Apr-June	Entire U. S.	To 0.6 m	Annual, ascending stems, variable branching, full sun	Prefers moist soils, in waste places, pest plant in some areas
Lespedeza (Lespedeza striata)[3]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-May	Entire U. S.	To 0.6 m	Perennial, shrubby, full sun	Cultivated for forage, hay, and silage, high-way rights-of-ways, well-drained soils
Lupine (Lupinus polyphyllus)	Seeds	May-Sept	Dry, cool area soak with hot H_2O prior to planting	Apr-June	PNW, CA, SW	To 0.5 m	Perennial, shrubby, full sun	Prefers dry, sandy soils
Malta starthistle (Centaurea melitensis)	Seeds	Apr-Sept	Dry, cool area	Feb-Apr	Entire U. S.	To 1.3 m	Annual, much branched, spiny yellow flowers, full sun	Occurs in most soils, waste and cultivated areas, pest plant
Mapleleaf goosefoot (Chenopodium hybridum)[1]	Seeds	Jul-Sept	Dry, cool area	Apr-June	Entire U. S. except PNW, CA	To 2.5 m	Annual, erect, bright green, branched, shade to full sun	Occurs in woods and thickets or in open, most soil types
Marsh pea (Lathyrus palustris)[1]	Seeds (inoculated)	May-Sept	Dry, cool area	Feb-June	Entire U. S.	To 1.3 m	Perennial, viney shrub, very persistent, full sun	Prefers moist areas
Marsh pepper (Polygonum hydropiper)[1]	Seeds	Jul-Sept	Dry, cool area	Mar-June	Entire U. S.	To 0.6 m	Annual, erect, reddish green, may be branched, full sun	Occurs in moist waste places, sometimes in standing water
Maximillian's sunflower (Helianthus maximilliani)	Seeds	Aug-Nov	Dry, cool area	Apr-Jul	MA, SE, MS, SP, MP, NP, PNW	To 2 m	Upright, coarse, stout, annual, full sun	Occurs in most soils, attractive flowers
Mexican tea (Chenopodium ambrosioides)[1]	Transplants, seeds	Aug-Oct	Dry, cool area	Apr-June	Entire U. S.	To 1 m	Annual in north, perennial in south, much branched, erect, full sun	Pest plant, occurs in most soils, in cultivated and waste areas
Musk filaree (Erodium moschatum)	Seeds	Feb-July	Dry, cool area	Nov-April	CA	To 0.5 m	Winter annual, semierect, full sun	Prefers dry well-drained soils
Narrowleaf vetch (Vicia angustifolia)[1,3]	Seeds	Feb-Apr (south) Apr-Jun (north)	Dry, cool area	Oct-Dec (south) Feb-May (north)	Entire U. S.	To 1 m	Perennial, viney, trailing, spreading, full sun	Cultivated for pastures, hay, and silage

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Nodding smartweed (Polygonum lapthifolium)[1]	Seeds	June-Sept	Dry, cool area	March-June	Entire U. S.	To 1 m	Annual, much branched, nodes swollen, good seed producer, full sun	Occurs in most soils and in waste and cultivated areas
Nutsedge (Cyperus filiculmis)[1]	Corms, seeds	June-Aug	Dry, cool area	March-June	NP, MP, SP, FL	To 0.5 m	Perennial, hard oblong corms, ascending, full sun	Occurs in dry fields and on hills
Olney threesquare (Scirpus olneyi)[1]	Transplants, seeds	Sept-March	In sand beds or in sand pots	April-June	Entire U. S. coastline	To 2.3 m	Perennial, upright, stems 3-winged, full sun	Occurs in coastal and fresh moist areas, tolerates salinity
Orache (Atriplex patula)[1]	Seeds	Aug-Oct	Dry, cool area	April-June	Entire U. S. coastline	To 1 m	Annual, widely branched, fruiting bracts, fleshy, full sun	Occurs in saltmeadows, along coasts, and inland areas
Partridge pea (Cassia fasciculata)[1,3]	Seeds (inoculated)	July-Oct	Dry, cool area, soak seeds in water before planting	April-June	Eastern U. S.	To 1 m	Annual, widely branched, erect, spreading, full sun	In dry soils, common in south in cultivated fields and disturbed areas
Pennsylvania smartweed (Polygonum pennsylvanicum)[1]	Seeds	July-Sept	Dry, cool area	March-June	Eastern and mid U. S.	To 1.3 m	Annual, ascending, branched stems, full sun	Occurs on most soils, prefers moist soil, a sometimes pest plant
Pickleweed (Rumex occidentalis)[1]	Seeds	May-Aug	Dry, cool area	April-June	CA, PNW, NE, SW	To 1 m	Perennial, stout stem, erect, unbranched, full sun	Prefers wet places
Pokeberry (Phytolacca americana)[1]	Seeds	Sept-Oct	Dry, cool area	Mar-June	Entire U. S. except NP, PNW, MW, SW	To 3 m	Robust perennial, with several purple stems, full sun to shade	Occurs in most soil types, and waste places
Prostrate knotweed (Polygonum aviculare)[1]	Seeds	June-Oct	Dry, cool area	Apr-June	Entire U. S.	To 0.6 m	Annual, prostrate or ascending stems, creeping full sun	Pest plant in many areas, occurs in most soils
Prostrate pigweed (Amaranthus blitoides)	Seeds	June-Oct	Dry, cool area	Apr-June	NE, GL, MRV, NP	To 0.6 m	Annual, many branched, prostrate, spreading, full sun	Prefers well-drained soils, occurs in waste areas, pest plant
Prostrate spurge (Euphorbia supina)	Seeds	May-Sept	Dry, cool area	Mar-June	Entire U. S.	To 0.5 m	Perennial, procumbent branches, stout at rootstock, full sun	Prefers well-drained soils
Purple nutsedge (Cyperus rotundus)[1]	Tubers, seeds	July-Sept	Moist, cool area (tubers) dry, cool area (seeds)	March-July	Entire U. S.	To 0.5 m	Perennial, extremely hardy and persistent, full sun	Pest plant in lawns, gardens, fields, pastures
Purple vetch (Vicia americanus)[1]	Seeds (inoculated)	Mar-May (south) May-Jul (north)	Dry, cool area	Nov-Feb (south) Mar-May (north)	Entire U. S.	To 1 m	Perennial, viney, trailing, spreading, full sun	Cultivated for pastures, hay, and silage
Red clover (Trifolium pratense)[1,3]	Seeds (inoculated	Mar-Apr (south) Apr-Sep (north)	Dry, cool area	Jan-Mar (south) Mar-Jun (north)	Entire U. S. except MW	To 0.6 m	Perennial, ascending stems, many branched, full sun	Cultivated as forage and hay crops, soil conservation areas
Redroot pigweed (Amaranthus retroflexus)[1]	Seeds	June-Oct	Dry, cool area	March-June	Entire U. S.	To 1 m	Coarse, summer annual, deep red taproot, very hardy, and persistent, shade to full sun	Occurs on most soil types, pest plant in agronomic and feedlot situations
Reseeding soybean (Glycine ussuriensis)[3]	Seeds	Sept-Nov	Dry, cool area	Mar-July	SE, MC	To 4 m	Annual legume, viney stems, full sun	Cultivated as waterfowl food, occurs in most soils
River bulrush (Scirpus fluviatilis)[1]	Root stock	Sept-April	In sand beds or pots of sand	April-June	NE, MA, SE, CA	To 2 m	Perennial, erect, widely spreading seed head, full sun	Occurs in moist areas and interior U. S.

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Saltmarsh bulrush (*Scirpus robustus*)[1,2]	Root stock	Sept-March	In sand beds or pots of sand	March-June	MS, SP, CA, PNW	To 2 m	Perennial, spiney seed, triangular stems, full sun	Prefers marshes, occurs on dredged material islands
Saltwort (*Salsola kali*)[1]	Transplants	Sept-March	In sand beds or in pots of sand	March-June	NE, MA, SE, FL	To 0.6 m	Annual, spiny, much branched, gray leaves, full sun	Prefers coastal moist areas, tolerates brackish soils
Sea blite (*Suaeda maritima*)[1]	Seeds	July-Sept	Dry, cool area	March-June	Entire U. S. in salt marshes	To 1 m	Annual, much branched, full sun	Prefers coastal moist areas, tolerates salt spray
Sea ox-eye (*Borrichia frutescens*)[3]	Seeds, transplants	July-Sept (seeds) Sept-March (trans.)	Dry, cool area (seeds) B&B or potted (trans.)	Feb-May	Eastern and southern U. S. coasts	To 0.5 m	Shrubby, fleshy, gray foliage, full sun	Occurs in sandy, coastal areas, tolerates salinity
Seashore lupine (*Lupinus littoralis*)[1]	Seeds	May-Sept	Dry, cool area, soak in H_2O before planting	March-June	PNW, CA	To 0.5 m	Perennial, scrubby, full sun	Prefers sandy beaches and marshes
Seaside dock (*Rumex maritima*)[1]	Seeds	July-Oct	Dry, cool area	April-June	Entire U. S. except SE, FL, MS	To 0.1 m	Perennial, deep roots, erect, fast growing, full sun	Prefers moist sandy areas, tolerates salt spray
Seaside goldenrod (*Solidago sempervirens*)[1]	Seeds	Aug-Dec	Dry, cool area	April-June	Eastern and southern U. S. coasts	To 2.6 m	Perennial, stout, erect, very leafy, large flower, full sun	Occurs on coasts and dredged material islands
Seaside plantain (*Plantago maritima*)[1]	Transplants, seeds	Mar-Oct (trans) Jun-Sept (seeds)	In sand beds or pots, dry, cool area	March-June	Entire coastal U. S.	To 0.2 m	Annual and perennial, fleshy rootstock and stems, full sun	Prefers salt marshes and seashores, tolerates salinity
Sericea lespedza (*Lespedeza cuneata*)[3]	Seeds	Sept-Dec	Dry, cool area	March-June	FL, MP, MA, SE, MRV, SP, MS	To 1 m	Woody perennial, dense fine foliage, good seed production, full sun	Occurs in moist soils, used on rights-of-ways, in pastures, hay fields, and conservation projects
Sheep sorrel (*Rumex acetosella*)[1]	Seeds	May-June	Dry, cool area	Feb-April	Entire U. S.	To 0.3 m	Perennial, basal rosette, full sun	Grows in infertile acid soils, will die in fertile soils
Showy tick-trefoil (*Desmodium canadense*)[1]	Seeds (inoculated)	July-Sept	Dry, cool area	April-June	Eastern U. S.	To 1.6 m	Perennial, erect, much branched, pubescent, shade or sun	Prefers rich soils, grows in woods or open areas
Silverleaf croton (*Croton punctatus*)[1]	Seeds	Aug-Oct	Dry, cool area	April-June	FL, SE, MS	To 1 m	Annual, many branched, silver leaves, full sun	Occurs in coastal soils, tolerates salt spray, tolerates drought
Southern bulrush (*Scirpus californicus*)[1]	Root stock	Sept-March	In sand beds or pots of sand	March-June	SE, MS, FL, CA	To 4 m	Perennial, triangular stems, upright, droopy spikelets, full sun	Occurs in coastal moist areas, tolerates brackish soils
Southern ragweed (*Ambrosia bidentata*)[1]	Seeds	July-Oct	Dry, cool area	April-June	SE, MS, SP	To 1 m	Annual, hirsute, many branched, full sun	Occurs in dry upland soils, pest plant, occurs in waste areas
Soybean (*Glycine max*)[1,2,3]	Seeds (inoculated)	Sept-Oct	Dry, cool area	April-July	Entire U. S.	To 0.6 m	Annual, fast growing, high seed production, full sun	Cultivated extensively for beans, excellent wildlife food
Spotted burclover (*Medicago arabica*)	Seeds (inoculated)	Feb-April (south) April-July (north)	Dry, cool area	Nov-Jan (south) Feb-May (north)	Entire U. S.	To 0.5 m	Annual, spreading, stout, spiny seeds, full sun	In poor, dry soils
Spotted spurge (*Euphorbia maculata*)[1]	Seeds	June-Nov	Dry, cool area	April-July	Entire U. S.	To 0.4 m	Annual, branched stem, prostrate, spreading, full sun	Prefers dry soils

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Herbs (Continued)								
Squarestem spikerush (*Eleocharis quadrangulata*)	Transplants, seeds	Apr-Jul (trans.) Jun-Aug (seeds)	In sand beds or pots (trans.), dry, cool area (seeds)	March-July	Entire U. S.	To 1 m	Perennial, slender stems, square stems, full sun	Prefers moist areas, occurs on coasts in fresh water
Sunflower (*Helianthus giganteus*)[1]	Seeds	July-Oct	Dry, cool area	April-June	Eastern and mid U. S.	To 4 m	Perennial, fleshy roots, creeping rootstock, branching, full sun	Prefers moist areas, stems often purple, showy flowers
Schweinitz's nutsedge (*Cyperus schweinitzii*)[1]	Seeds	Aug-Oct	Dry, cool area	April-June	NE, GL, MRV, NP, MP	To 1 m	Perennial, thickened corms, slender stems, full sun	Prefers sandy soils, and moist areas
Tansy mustard (*Descurainia pinnata*)[1]	Seeds	May-July	Dry, cool area	March-May	Entire U. S. except CW	To 0.6 m	Annual, erect, branched, slender ascending branches, full sun	Prefers dry soils
Tropic croton (*Croton glandulosus*)[1]	Seeds	Aug-Oct	Dry, cool area	April-June	SE, FL, MS, SP, MA, MRV	To 1.5 m	Annual, rough, hardy, full sun	Pest in pasture areas, occurs in moist soils
Tumble-weed (*Amaranthus albus*)[1]	Seeds	June-Sept	Dry, cool area	Mar-June	Entire U. S.	To 1 m	Annual, pale green, erect, bushy branched	Occurs in most soils, prefers dry
Virginia pepperweed (*Lepidium virginicum*)[1]	Seeds	May-Nov	Dry, cool area	Mar-June	Entire U. S. except CA, PNW	To 0.5 m	Many branched, hardy, full sun	In dry soils, pest plant in fields, on many dredged material islands
Western ragweed (*Ambrosia psilostachya*)[1]	Seeds	Sept-Nov	Dry, cool area	Apr-June	MW, CA, SW, NE, GL, NP, MP, SP	To 2 m	Perennial, creeping rootstock, hardy, full sun	Prefers well-drained soils, a pest plant
White clover (*Trifolium repens*)[1,2,3]	Seeds (inoculated)	Mar-May (south) May-Sep (north)	Dry, cool area	Jan-Mar (south) Mar-Jun (north)	Entire U. S. except MW	To 0.3 m	Shallow rooted perennial with creeping branches, full sun	Cultivated as pasture and hay crops, occurs on moist soils
White sweetclover (*Melilotus alba*)[1]	Seeds (inoculated)	Apr-May (south) Jun-Nov (north)	Dry, cool area	Nov-Feb (south) Mar-May (north)	Eastern U. S.	To 3.3 m	Annual, erect or ascending, branching, full sun	Roadsides, pastures, lawns, occurs in moist soils
Wild bean (*Strophostyles helvola*)[1]	Seeds (inoculated)	Sept-Oct	Dry, cool area	March-June	Eastern and mid-U. S.	To 3 m	Summer annual legume, viney, full sun	Occurs on beaches, tolerates salt spray
Wild buckwheat (*Polygonum convolvulus*)[1]	Seeds	June-Nov	Dry, cool area	Mar-June	Entire U. S.	To 1 m	Annual, viney plant, rapid growth, full sun	Occurs in most soils, a pest plant in crops
Wild sensitive pea (*Cassia nictitans*)	Seeds (inoculated)	June-Nov	Dry, cool area	Mar-June	Entire U. S.	To 0.3 m	Annual, erect, branching, full sun	Prefers dry soil
Wild strawberry (*Fragaria virginiana*)	Seeds, transplants	Mar-May (south) May-Jul (north)	In sand beds (trans.) dry, cool area (seeds)	Sept-Feb	Eastern and mid U. S.	To 0.1 m	Perennial, stout, slender stalks, shade or sun	Prefers dry, rich soil, edible berries
Woolly croton (*Croton capitatus*)[1,3]	Seeds	Aug-Oct	Dry, cool area	April-June	MA, SE, MS, SP, MP, MRV	To 2.3 m	Robust, branching annual, good seed production, full sun	Pest in pastures, grows on most soils, prefers sandy areas
Woolly indianwheat (*Plantago purshii*)[1]	Seeds	May-Aug	Dry, cool area	March-June	MW, SP, NP, MP	To 0.3 m	Annual, ascending leaves, slender stems, full sun	Prefers dry plains and prairies, other dry areas
Yellow starthistle (*Centaurea solstitialis*)[1]	Seeds	July-Sept	Dry, cool area	April-June	NE, MA, MRV, MW, CA	To 0.6 m	Annual, branched, winged stems, full sun	Pest plant in cultivated areas
Yellow sweetclover (*Melilotus officinalis*)[1]	Seeds (inoculated)	May-Jun (south) Jul-Nov (north)	Dry, cool area	Nov-Feb (south) Apr-Jun (north)	Eastern U. S.	To 0.3 m	Annual, erect or ascending, branching, full sun	Occurs in waste areas and fields, most soils

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Vines								
American bittersweet (Celastrus scandens)	Seeds	Sept-Nov	Dry, cool area	March-June	NE, MA, SP, SW, GL, MRV	To over 8m	Twining, woody vine, ascending trees or trailing on ground	Prefers rich, moist soil
Bamboo vine (Smilax laurifolia)	Tuber, seeds	Sept-Mar (tubers) June-Sep (seeds)	In soil beds, dry, cool area	Feb-June	MA, SE, FL, MS, SP	Long trailing stems	Tuber rootstocks, stout, hardy, evergreen, spines, shade	Prefers moist areas in woods and thickets
Beach morning glory (Ipomoea stolonifera)[1]	Rooted stems, seeds	Sept-April	In sand beds, dry, cool area	Mar-June	Eastern U. S. and SP	To 4 m	Perennial, twining, large roots	Prefers sandy beaches and dunes
Common greenbrier (Smilax rotundifolia)[1]	Seeds	May-Aug	Dry, cool area	Mar-June	Eastern and mid-U. S.	Long trailing stems	Woody, 4-angled shoots, spiny, shade to sun	Prefers moist areas in woods and thickets, occurs in dry areas
Crossvine (Bignonia capreolata)	Seeds	May-August	Dry, cool area	Mar-June	SE, MS, FL, MRV	To 20 m	Woody, cross visible in cross-section, shade or sun	Prefers moist woods, occurs in moist open areas
Fox grape (Vitis labrusca)[1]	Seeds	Aug-Sept	Remove pulpy coat dry, cool area	Mar-June	MA, NE, MRV, SE	To 30 m	Climbing, large stem, shade	Prefers thickets, native stock for cultivated grape hybrids
Fringed catbrier (Smilax bona-nox)[1]	Tuber, seeds	Sept-Mar (tubers) Apr-Jul (seeds)	In soil beds (tubers) dry, cool area (seeds)	Apr-June	Eastern and mid-U. S.	Long trailing stems	Woody, 4-angled, large tubers, spiny leaves and stems, shade or sun	Prefers thickets, moist areas, occurs in dry habitats
Frost grape (Vitis vulpina)[1]	Transplants	June-Oct	Remove pulpy coat dry, cool area	Mar-June	NE, MA, SE, MW	Long trailing stems	Climbing, pubescent, thin shining leaves, shade or sun	Prefers moist rocky areas, occurs in open moist areas
Japanese honeysuckle (Lonicera japonica)[1]	Root stock, transplants	June-Sept	Dry, cool area	Feb-June	Entire U. S.	Long climbing stems	Pubescent, fragrant, persistent, shade or sun	Pest plant in unkept areas, excellent forage plant
Kudzu (Pueraria lobata)[3]	Root stock, transplants	Sept-March	In soil beds or pots of soil	Feb-June	Entire U. S.	Long climbing stems	Hairy, 3-foliate leaves, sun or shade	Pest plant in unkept areas, excellent cover vine, ornamental
Lanceleaf greenbrier (Smilax smallii)	Seeds	April-August	Dry, cool areas	Mar-June	SE, FL, SP, MS	Long trailing stems	Woody, slender, no tubers or spines, shade or sun	Prefer dry thickets
Muscadine grape (Vitis rotundifolia)[1,3]	Seeds, transplants	Aug-Oct	Remove pulpy coat dry, cool areas	March-June	SE, MA, FL, SP, MP, MS	Long trailing stems	Woody, slender stems, large leaves shade or sun	Prefers moist sandy soil in thickets, occurs in silt and clay in open
Peppervine (Ampelopsis arborea)[1]	Seeds	Sept-Oct	Dry, cool area	March-June	Entire U. S.	Long climbing stems	Numerous tendrils, aerial roots, fast growing, dense cover, sun or shade	Prefers wood and thickets, dry soil, but occurs in open areas
Sawbrier (Smilax glauca)	Seeds	Sept-Mar (tubers) June-Aug (seeds)	In soil beds (trans.) dry, cool area (seeds)	March-May	Eastern U. S. and SP	Long trailing stems	Deep, tuberous rootstock, stout spines, shade or sun	Prefers dry sandy soil, also called sassparilla
Summer grape (Vitis aestivalis)[1]	Seeds	Sept-Oct	Remove pulpy coat, dry, cool area	March-June	SE, MS, FL	Long trailing vine	Evergreen, coarse-stemmed, persistent, sun or shade	Prefers dry soil in woods, it occurs in open
Supplejack (Berchemia scandens)[1]	Seeds, transplants	May-August	Dry, cool area	March-June	MS, SE, FL, SP	High climbing stems	Shrub, tough, stout leaves and stems	Prefers moist woods, but occurs in open areas
Virginia creeper (Parthenocisssus quinquefolia)[1]	Seeds	Aug-Oct	Remove pulpy coat dry, cool areas	March-June	NE, MA, MRV, MS, SP, MP, NP	High climbing stems	Large leaves, bark loose and shreddy, tendrils, shade or sun	Prefers dry soil in thickets, occurs in the open
Wild bamboo (Smilax auriculata)[1]	Seeds	Oct-Nov	Remove pulpy coat dry, cool area	March-June	SE, MS, FL	Long trailing vine	Evergreen, coarse stemmed, persistent, sun or shade	Forms low thickets in the open or wood areas

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees								
American elderberry (Sambucus canadensis)[1]	Transplants, seeds	Sept-March July-Sept	In nursery, dry, cool place	Feb-June	Eastern and mid-U. S.	To 9 m	Deciduous, many stemmed, large flowers, full sun	Prefers moist soils, but occurs over wide soil ranges
American hornbeam (Carpinus caroliniana)	Transplants	Sept-March	B&B* or potted in nursery	Feb-June	Eastern and mid-U. S.	To 9 m	Deciduous, round crown, partial or full shade	Prefers dry soils, often is understory in open woods
American plum (Prunus americana)[1]	Transplants, seeds	Sept-March July-Sept (seeds)	B&B or potted in nursery, dry, cool place	Feb-June	Eastern and mid-U. S.	To 9 m	Deciduous, spreading crown, full to partial sun	Prefers moist soils, occurs in dense thickets, edible fruit
Arrowwood viburnum (Viburnum dentatum)	Transplants	Sept-March	B&B or potted in nursery	Feb-May	MS, SE	To 3 m	Deciduous, shrubby, large flowers, partial sun	Prefers moist soils, common as understory
Autumn olive (Eleagnus umbellata)[1,2,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	MA, SE, MS, FL, SP	To 5 m	*Evergreen in south* deciduous in north full sun, shrub full to partial sun	Prefers dry soils, drought resistent, very hardy
Bayberry (Myrica pensylvanica)[1]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	NE, MA	To 3 m	*Evergreen*, very dense, full sun, shrub	Prefers sandy soils, *occurs in coastal areas*, common on dredged material, important habitat plant
Beach plum (Prunus maritima)[1]	Transplants, seeds	Oct-March	B&B or potted in nursery	Feb-May	MA, NE	To 2 m	Deciduous, low, many branched, full sun	Prefers sandy, coastal soils, edible fruit
Bearberry (Arctostaphylos uva-ursi)	Transplants, seedlings	Sept-March	B&B or potted in nursery, cleaned and stratified (seeds)	Feb-June	NE, MA, GL, MRV, NP, MW, CA, PNW	To 0.2 m	Evergreen, spreading shrubby, slow growth, shade to full sun	Occurs in dry, sandy, and rocky soils
Beautyberry (Callicarpa americana)[1]	Transplants, seeds	Sept-March	B&B or potted in nursery	Feb-June	SE, MS, FL, MA	To 2.5 m	Deciduous, shrubby abundant fruit, full sun to partial shade	Grows in variety of soil conditions, does best as understory plant
Bicolor lespedeza (Lespedeza bicolor)	Transplants	Sept-Nov Mar-June	B&B or potted in nursery	March-June	MA, SE, FL, SP	To 3 m	Deciduous legume, irregular *shrub*, full sun	Tolerates poor soils and *drought conditions*, prefers well-drained, dry areas
Black raspberry (Rubus occidentalis)[1]	Transplants	Sept-March	Potted in nursery or soil bed	Feb-June	NE, MA, SE, SP, MP	To 4 m	Deciduous, spiny, glaucous, roots from stem tips, full sun	Occurs in most soils, persistent, pest plant in pastures
Blue brush (Ceanothus thryiflorus)	Seeds	June-Aug	Dry, cool area	Feb-June	PNW, CA	To 1 m	Deciduous, shrubby, shade to sun *	Occurs in dry, rocky, sandy areas, used for tea substitute by pioneers
Blue elderberry (Sambucus caerulea)	Seeds	July-Oct	Cleaned and stratified seeds	Feb-June	SW, CA, PNW	To 8 m	*Deciduous, many stemmed*, showy flowers, full sun	Occurs in most soils in open or in edges of woods
Brazilian peppertree (Schinus terebinthifolius)[1]	Cuttings, transplants	Oct-April	In rooting medium (cuttings), B&B or potted (trans.)	Oct-June	FL	To 10 m	Evergreen, many branched, tropical, showy flowers, full sun	Occurs in most soils below freeze line in Florida, common on dredged material islands
Brewer saltbush (Atriplex breweri)	Seeds	June-Sept	Dry, cool area	Feb-June	CA, SW	To 0.5 m	Shrubby, dense, full sun	Occurs in dry, saline soil, also known as sage brush
Buffaloberry (Shepheria candensis)[1]	Seeds	July-Sept	Cleaned and stratified	March-June	NE, MA, GL, NP, SW	To 2.5 m	Deciduous, shrubby, shade to sun	Occurs in moist soils

(Continued)

* Balled and burlapped.

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Bush lupine (*Lupinus albifrons*)	Seeds	July-Sept	Dry, cool area	March-June	PNW, CA	To 0.5 m	Perennial, shrubby, many seed pods, full sun to part shade	Occurs in dry and well-drained soils, both in open and in edges of woods
California blackberry (*Rubus ursinus*)[1]	Seeds, transplants	Sept-Apr (trans.) Jun-Jul (seeds)	B&B or potted in nursery (trans.) cleaned and stratified (seeds)	Feb-May	PNW, CA	To 1 m	Perennial, woody, many branched, arching, full sun	Occurs in dry, well-drained areas in most soils, very dense wood
California buckthorn (*Rhamnus californica*)	Transplants	Sept-Mar	B&B or potted in nursery	Feb-May	PNW, CA	To 2 m	Deciduous, shrubby, thorny, full sun	Occurs in dry soils
Canadian serviceberry (*Amelanchier canadensis*)[1]	Seeds, transplants	Sept-Apr (trans.) May-June (seeds)	B&B or potted in nursery (trans.) cleaned and stratified (seeds)	Mar-June	SE, NE, MA	To 7 m	Deciduous, upright, shrubby, pubescent young twigs, full to partial sun	Prefers moist areas, occurs in most soils
Carolina ash (*Fraxinus caroliniana*)	Transplants	Sept-March	B&B or potted in nursery	Mar-June	MA, SE, FL, MP, MS, SP	To 14 m	Deciduous, pubescent, 5-7 leaflets, shade or sun	Occurs in moist or wet soils, in woods or in open
Carolina rose (*Rosa carolina*)[1]	Hips, cuttings	July-Oct (hips) April-Oct (cuttings)	Cleaned and stratified (hips), in rooting medium (cuttings)	Feb-June	Eastern and mid U. S.	To 1.5 m	Deciduous, thorny, arching, fast growing, full sun	Occurs in most soils, well-drained to dry, open areas
Cascara buckthorn (*Rhamnus purshiana*)[1]	Seeds	July-Sept	Cleaned and stratified	Apr-June	PNW, CA	To 7 m	Deciduous, shrubby, shade to full sun	Occurs in most soils, open areas or in woods
Cherry laurel (*Prunus caroliniana*)[1,2]	Transplants, cuttings	Sept-March	B&B or potted in nursery	March-June	SE, MS, MA	To 10 m	Evergreen, shrubby, ascending branches, full sun to partial shade	Occurs in most soils, cultivated as an ornamental
Chickasaw plum (*Prunus angustifolia*)[1]	Seeds	June-July	Cleaned and stratified	Feb-May	SE, MS, MA, SP	To 2 m	Deciduous, shrubby, thorny, large fruit, full sun	Ferns, thickets, occurs in most dry and well-drained soils
Common buckthorn (*Rhamnus caroliniana*)	Transplants	Sept-March	B&B or potted in nursery	Feb-June	SE, FL, MS, SP	To 10 m	Deciduous, shrub or tree, seeds few, shade or sun	Prefers moist soils, in open or edges of woods
Common chokecherry (*Prunus virginiana*)[1]	Seeds	Aug-Sept	Cleaned and stratified	Mar-June	MS, MBV, GL, MP, MW, SW, PNW, CA	To 10 m	Deciduous, shrubby underground stems, forms thickets, shade or sun	Occurs in most soils including sand dunes and rocky areas
Common deerberry (*Vaccinium stamineum*)	Transplants, seeds	Sept-Mar (trans.) Apr-June (seeds)	B&B or potted, cleaned and stratified	Feb-May	Eastern U. S.	To 2 m	Deciduous, much branched, irregular, shade or sun	Occurs in dry soils in woody, thickets, and edges of woods
Common juniper (*Juniperus communis*)[1]	Seeds, seedlings	Sept-March (seedlings) Sept-Nov (seeds)	B&B or potted in nursery, stratified at 5°C	March-June	GL, MS, SE		Spreading, narrowleaf evergreen shrub, full sun	Used as an ornamental shrub over a large range, quite hardy, tolerates alkaline soils
Common sweetleaf (*Symplocos tinctoria*)	Transplants	Sept-March	B&B or potted in nursery	Feb-May	MA, SE, MS	To 3 m	Deciduous, large waxy leaves, sweet taste, shade or sun	Occurs in woods and thickets, mostly in shade, sometimes in open areas
Crabapple (*Malus angustifolia*)[1]	Transplants, seeds	Sept-March (trans.) May-July (seeds)	B&B or potted (trans.) cleaned and stratified (seeds)	Feb-May	MA, SE, PA, MS	To 7 m	Deciduous, thorny, bitter fruit, showy flowers, full sun	Occurs in most dry soils, in open thickets
Dahoon (*Ilex cassine*)[1]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	SE, FL, MS	To 8.5 m	Evergreen, thorny, slow growing, full sun	Prefers sandy moist areas, in woods or open, in coastal areas
Downy serviceberry (*Amelanchier arborea*)	Transplants	Sept-March	B&B or potted in nursery	Feb-June	SE, MS	To 14 m	Deciduous, large leaves, pubescent, shade or sun	Prefers dry, soils, in woods or open areas

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Eastern hophornbeam (*Ostrya virginiana*)[1]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	NE, GL, MP, SP, MRV, SE, MA, FL, MS	To 10 m	Deciduous, hardwood, leaves yellow-green, shade or sun	Prefers dry soils, in woods or in open areas
Elderberry (*Sambucus glauca*)[1]	Seeds	June-Aug	Cleaned and stratified	Feb-June	Me, PNW, CA, SW	To 7 m	Deciduous, large seed-heads, few branches	Occurs in dry soils
Elderberry (*Sambucus callicarpa*)[1]	Seeds	June-Aug	Cleaned and stratified	Feb-June	PNW, CA	To 7 m	Deciduous, shrubby	Occurs in dry soils
Evergreen blackberry (*Rubus laciniatus*)[1]	Seeds	June-July	Cleaned and replanted	Aug-Sept	Eastern U. S.	To 4 m	Stout, deciduous, arching branches, persistent	Pest plant in pastures, cultivated for fruit
Firethorn (*Pyracantha coccinea*)[3]	Seeds, transplants	Sept-Jan (seeds) Sept-Mar (trans.)	Cleaned and stratified (seeds), B&B or potted (trans.)	Feb-May	MA, SE, SP, FL,MS	To 4 m	Evergreen, irregular, hardy, showy flowers and fruit, full sun	Occurs in most soils, does well in wet or dry areas, cultivated as ornamental
Flowering dogwood (*Cornus florida*)[1]	Transplants	Oct-Feb	B&B or potted in nursery	Feb-April	Eastern U. S. and SP	To 15 m	Deciduous, bushy crown, showy flowers, shade or sun	Occurs in dry soils, cultivated as ornamental, in woods or in open areas
Gallberry (*Ilex glabra*)[1]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	NE, MA, SE, FL, MS	To 2 m	Evergreen, shrubby, dotted underside of leaves, shade or sun	Prefers sandy soil, occurs on coasts
Gray dogwood (*Cornus racemosa*)[1]	Transplants	Sept-March	B&B or potted in nursery	Feb-May	Eastern and mid-U. S.	To 2 m	Dense deciduous, shrubby, gray bark, shade or sun	Prefers moist soils, occurs in thickets, woods, open areas
Ground blueberry (*Vaccinium myrsinites*)[1]	Seeds	May-June	Cleaned and stratified	Jan-March	SE, MS, MA	To 2 m	Evergreen, pubescent, few branches, shade or sun	Prefers moist areas, in woods or open areas
Groundsel tree (*Baccharis halimifolia*)[1]	Seeds, transplants	Sept-Nov	B&B or potted (trans.) dry, cool area (seeds)	Jan-May	SE, MA, MS, SP, NE	To 3.5 m	Many branched, deciduous shrubby, full sun	Prefers moist areas, occurs on sea coasts, tolerates salinity
Halberd-leaved willow (*Salix hastata*)[1,3]	Transplants	Sept-March	B&B or potted	Feb-June	Entire U. S.	To 10 m	Many branched, deciduous full sun	Cultivated as ornamental
Hibiscus (*Hibuscus moscheutos*)[1]	Seeds, transplants	Sept-Mar (trans.) June-Aug (seeds)	B&B or potted (trans.) dry, cool area (seeds)	Feb-June	NE, SE, MA, FL, MS, SP	To 2.3 m	Deciduous, many branched, erect, large seed pods, full sun	Prefers moist soils, tolerates some salinity, occurs on coasts and inland
Highbush blueberry (*Vaccinium corymbosum*)[1,3]	Seeds, cuttings	Jan-Feb (trans.) June-Aug (seeds)	Cooled, cleaned, and planted (seeds) layered in rooting medium (trans.)	Feb-June	NE, SE, MA, FL, MS	To 4 m	Deciduous, erect, hardy, many branched, shade to full sun	Occurs in moist soils
Hollyleaf cherry (*Prunus ilicifolia*)	Seeds, transplants	July-Sept	Cleaned and stratified	Nov-May	CA	To 8 m	Evergreen, serrated holly-like leaves, full sun	Prefers dry soils
Honey mesquite (*Prosopis juliflora*)[1]	Seeds	Aug-Sept	Dry, cool area	Feb-May	SP, SW	To 14 m	Deciduous, shrubby, thorny irregular crown, full sun	Prefers dry, sandy, or loam soils, pest plant in western pastures
Hooker's willow (*Salix hookeriana*)[1]	Cuttings	year-round	Layered in rooting medium	Feb-June	PNW, CA	To 10 m	Deciduous, shrubby, pubescent, full sun	Prefers moist areas, tolerates shifting sand and flooding
Japanese lespedeza (*Lespedeza japonica*)	Seeds, inoculated	May-Sept	Dry, cool area	Feb-June	Entire U. S.	To 1 m	Shrubby, woody, perennial, full sun	Cultivated for grazing
Low blueberry (*Vaccinium vacillans*)	Seeds	June-July	Cleaned and stratified	Oct-May	SE, MA, MS	To 0.6 m	Shrubby, erect, rhizomous, stout, shade or sun	Prefers dry areas, thickets or woods

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Mapleleaf viburnum (Viburnum acerifolium)	Seeds	July-Oct	Cleaned and stratified	Feb-May	SE, MS, MA	To 1 m	Deciduous, shrubby, maple shape leaf, shade or sun	Thickets or open areas
Marsh elder (Iva frutescens)[1]	Transplants	Oct-April	B&B or potted in nursery	Feb-May	NE, MA, SE, FL, MS, SP	To 4 m	Deciduous, many branched, serrated leaves, full sun	Prefers sandy, moist areas, occurs on coastal islands, dunes and marshes
Mountain blackberry (Rubus allegheniensis)	Seeds, rootstock	June-July (seeds) Year-round (rootstock)	Cleaned and replanted (seeds), in soil beds (root stock)	Sept-Nov (seeds) Feb-May (rootstock)	NE, MA, GL, MRV	To 3.5 m	Deciduous, hardy, very robust, prolific fruiting, full sun, spiny	Pest plant in pastures, occurs and thrives almost anywhere
Multiflora rose (Rosa multiflora)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	Entire U. S. except NP	To 4 m	Deciduous, arching, thorny, showy flowers, full sun	Pest plant in unkept pastures and fields, cultivated for windbreaks and cover
Myrtle oak (Quercus myrtifolia)	Transplants	Oct-March	B&B or potted in nursery	Oct-Mar	FL	To 15 m	Evergreen, leathery, full sun	Prefers sandy coastal soils, tolerates salt spray
Northern bayberry (Myrica pensylvanica)[1]	Transplants	Oct-Mar	B&B or potted in nursery	Feb-June	NE, MA	To 15 m	Evergreen, pubescent, dense, dark green, full sun	Prefers sandy coastal soils, tolerates salt spray
Oleander (Nerium oleander)[1,2,3]	Transplants	Oct-Mar	B&B or potted in nursery	Feb-April	SW, FL, MS	To 10 m	Evergreen, dense, upright stems, showy flowers, full sun	Prefers dry sandy soils, tolerates salt spray and drought, not freeze tolerant
Pacific bayberry (Myrica californica)	Transplants	Sept-Mar	B&B or potted in nursery	Mar-June	PNW, CA	To 9 m	Evergreen, shrubby, dense foliage, full sun	Prefers sandy sites, occurs in coastal areas, tolerates salt spray
Pacific dogwood (Cornus nuttallii)[1]	Transplants	Sept-Mar	B&B or potted in nursery	Feb-June	PNW, CA	To 3 m	Deciduous, shrubby, erect, bushy, full sun and shade	Prefers well-drained areas
Pacific wax myrtle (Myrica californica)	Transplants	Oct-Feb	B&B or potted in nursery	Feb-May	PNW, CA, coasts	To 11 m	Evergreen, thick shrubs, ascending branches, full sun	Prefers moist areas, occurs in marshes, gullies, sand dunes, islands
Pacific willow (Salix lasiandra)[1]	Cuttings, transplants	Year-round (cut.) Sept-Mar (trans.)	In rooting medium (cut.), B&B or in pots (trans.)	Feb-May	PNW, CA	To 4 m	Deciduous, shrubby, fast growing, full sun	Prefers moist areas
Poison ivy (Rhus radicans)[1]	Transplants	Sept-Mar	B&B or in pots in nursery	Feb-June	Entire U. S.	To 5 m	Deciduous, fast growing, full sun	Prefers moist areas, vine form not recommended for planting
Possumhaw (Ilex decidua)[1,3]	Seeds	Sept-Dec	Cleaned and stratified	Mar-June	GL, SP, MP, MRV, SE, MS, MA, FL	To 10 m	Deciduous, red berries, very showy, shade or sun	Prefers moist areas, cultivated as ornamental
Possumhaw viburnum (Viburnum nudum)	Seeds	Aug-Oct	Cleaned and stratified	Mar-June	SE, MS, MA, FL	To 8 m	Deciduous, large leaves, shade or sun	Occurs in moist soils, in woods or in open
Purple osier willow (Salix purpurea)	Transplants, cuttings	Sept-March	In rooting medium, B&B or potted	Mar-June	MA, MRV, NE	To 4 m	Deciduous, purple stems, slender, full sun	Cultivated as an ornamental, prefers moist places, used in bank stabilization
Pussy willow (Salix discolor)[3]	Transplants, cuttings	Sept-March	B&B or potted in nursery	March-June	NE, NP, GL	To 8 m	Deciduous, shrubby, full sun	Prefers moist soils, widely used as an ornamental

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Quail brush (*Atriplex lentiformis*)	Seeds	July-Oct	Dry, cool area	Mar-May	SW	To 1 m	Deciduous, shrubby, pale green, full sun	Prefers dry, sandy soils tolerates salinity
Red alder (*Alnus rubra*)[1]	Transplants, cuttings	Year-round (cut.) Sept-Mar (trans.)	In rooting medium (cut.), B&B or in pots (trans.)	Feb-May	PNW, CA	To 15 m	Deciduous, shrubby, upright branches, full sun	Occurs on most soils, on cutover forest land, beaches, streams
Red buckeye (*Aesculus pavia*)	Transplants, seeds	Aug-Oct (seeds) Sept-Mar (trans.)	Stratified (seeds), B&B or in pots	Feb-May	SE, MS, SP	To 8 m	Deciduous, shrubby, shade or sun	Large fruit is inedible, occurs in most soils
Red osier dogwood (*Cornus stolonifera*)[1,3]	Cuttings, transplants	Aug-April (cut.) Sept-April (trans.)	In rooting medium B&B or potted	April-June	NE, MRV, GL, NP, SW, PNW, MW	To 2.3 m	Deciduous, shrubby, stoloniferous, full to partial sun	Occurs in moist soils, prefers moist poorly drained areas
Riverflat hawthorn (*Crateagus opaca*)	Seeds	April-June	Cleaned and stratified	March-May	SE, MA, MS	To 5 m	Deciduous, leathery, thorny, shade or sun	Prefers dry soils, in woods or in open, red fruit
Rough-leafed dogwood (*Cornus drummondii*)[1]	Transplants	Sept-March	B&B or potted	Feb-May	SE, MA, MS, SP, NP, MP	To 5 m	Deciduous, showy flowers, fast growing, sun or shade	Prefers moist areas, occurs in most soils
Russian olive (*Eleagnus angustifolius*)[1,2,3]	Seeds, transplants	Sept-Oct (seeds) Sept-March (trans.)	Cleaned and stratified (seeds), B&B or potted (trans.)	March-June	Entire U. S.	To 7 m	Evergreen, shrubby, spiny, irregular crown, full sun	Occurs in most soils, cultivated for wind break, roadside, ornamental
Rusty blackhaw (*Viburnum rufidulum*)	Seeds	July-Oct	Cleaned and stratified	Feb-April	SE, MS, MA, FL	To 3 m	Deciduous, leathery, shiny green, shade	Prefers dry areas, in woods, but occurs in thickets and open areas
Salal (*Gaultheria shallon*)[1,3]	Transplants, root stock	Sept-March	B&B or potted in nursery	Feb-June	PNW, CA	To 2 m	Evergreen, dark shiny leaves, shade	Prefers moist areas, cultivated for florist industry
Salmonberry (*Rubus spectabilis*)[1]	Seeds	June-Aug	Cleaned and in dry cool area	March-June	PNW	To 5 m	Deciduous, branching, leafy, shrubby, showy flowers, large fruit, shade	Occurs in moist areas, in woods and thickets
Saltbush (*Atriplex polycarpa*)[1]	Seeds	July-Oct	Dry, cool area	Feb-May	SW	To 1 m	Deciduous, shrubby, pale green, full sun	Prefers dry, sandy soils, tolerates drought and salinity
Saltcedar (*Tamarisk parviflora*)[1,3]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	MA, SW, SP, MS, FL	To 5 m	Evergreen, small foliage, irregular crown, full sun	Prefers dry, sandy soils, tolerates drought and salinity
Sandbar willow (*Salix interior*)[1,3]	Transplants cuttings	Sept-March	B&B or potted in nursery	March-June	NE, MRV, GL, MP, SP, MW	To 9 m	Deciduous, shrubby, dense, full sun	Prefers moist soils, riverbanks
Sand blackberry (*Rubus cuneifolius*)[1]	Seeds	May-July	Cleaned and stratified	Feb-June	MA, SE, FL	To 1 m	Deciduous, arching, erect, spiny, robust, full sun	Prefers dry, sandy areas
Sand pine (*Pinus clausa*)[1,2,3]	Transplants, seedlings	Oct-March	B&B or potted in nursery	Feb-May	FL, MS	To 6 m	Narrowleaf evergreen, shrubby, full sun	Grows in poor soils, tolerates droughty, sandy conditions, occurs on coasts
Sawtooth oak (*Quercus acutissima*)[1,2,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-May	SE, MS, FL, SP	To 10 m	Deciduous, irregular growth, full sun	Cultivated for wildlife food, occurs on most soils
Scotch broom (*Cytisus scoparius*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-May	PNW		Evergreen showy flowers, dense growth, full sun	Pest plant in some areas, cultivated as ornamental elsewhere
Sharp-toothed blackberry (*Rubus argutus*)[1]	Rootstock, seeds	Year-round (root.) June-July (seeds)	In soil beds (root.) cleaned and stratified (seeds)	Sept-Nov (seeds) Feb-May (rootstock)	SE, MA, FL, MS, MRV	To 2 m	Deciduous, hardy, very robust, prolific fruiting, full sun, spiny	Pest plant in pastures, occurs and thrives almost anywhere

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Shining sumac (*Rhus copallina*)[1]	Seeds, rootstock	Sept-Nov Sept-March	Cleaned and stratified (seeds), in soil beds (rootstock)	Feb-June	Eastern and mid-U. S.	To 4 m	Deciduous, little branching, lateral spreading roots, forms thickets, full sun	Occurs in moist soils, in open areas
Shore pine (*Pinus contorta*)[1,3]	Transplants, cuttings	Sept-March	B&B or potted in nursery	Feb-May	PNW, CA	To 12 m	Narrowleaf evergreen, spreading, full sun	Coastal dunes plant, very hardy, can be grown from seeds
Shrub verbena (*Lantana camara*)[1,3]	Seeds, transplants	May-Sept (seeds) Sept-Mar (trans.)	Dry, cool area (seeds) B&B or potted (trans.)	Jan-April	FL, SE, MS, SP	To 1 m	Deciduous, tropical, showy flowers, full sun	Cultivated as ornamental, prefers moist, sandy soils
Silky dogwood (*Cornus amomum*)[1]	Transplants	Sept-March	B&B or potted	Feb-June	Eastern and mid-U. S.	To 3.3 m	Deciduous, purplish stems, full sun	Prefers moist soils, in woods, and in open
Silky willow (*Salix sericea*)[1]	Transplants, cuttings	Year-round (cut.) Sept-Mar (trans.)	In rooting medium, B&B or potted (trans.)	March-June	NE, MA, GL, MBV	To 4 m	Deciduous, purplish stems, pubescent, full sun	Prefers wet to moist soils, in open areas
Sitka alder (*Alnus sinuata*)[1]	Transplants, cuttings	Year-round (cut.) Sept-Mar (trans.)	In rooting medium, B&B or potted (trans.)	Feb-May	PNW	To 10 m	Deciduous, shrubby, multistemmed, full sun	Prefers moist soils, in open areas
Smooth sumac (*Rhus glabra*)[1]	Seeds	Sept-Feb	Cleaned and stratified	Feb-June	Entire U. S.	To 2 m	Deciduous, shrubby, few branches, forms thickets from roots, full sun	Occurs in most soils, in open areas
Southern bayberry (*Myrica cerifera*)[1]	Transplants	Sept-Mar	B&B or potted	Feb-May	SE, MA, FL, MS, SP	To 5 m	Evergreen, dense, upright branches, full sun	Prefers moist, sandy areas, occurs on seacoasts and islands
Southern dewberry (*Rubus trivialis*)[1]	Seeds, transplants	April-May (seeds) Year-round (trans.)	Cleaned and stratified (seeds), B&B or potted (trans.)	Jan-March	SE, MS, FL, SP	To 1 m	Deciduous, persistent, large fruit, full sun	Occurs in most soils, excellent wildlife food
Sparkleberry (*Vaccinium arboreum*)	Seeds	May-July	Cleaned and stratified	Jan-May	SE, MA, SP, MS	To 10 m	Deciduous in north, evergreen in south, sprawling, shrubby, shade or full sun	Occurs in dry soils, in woods or open thickets
Squaw huckleberry (*Vaccinium stamineum*)	Seeds	May-June	Cleaned and stratified	Feb-June	Eastern and mid-U. S.	To 5 m	Deciduous, leathery, shrubby shade or sun	Occurs in dry woods or open thickets, edges of woods
Staghorn sumac (*Rhus typhina*)[1]	Seeds	Oct-Dec	Cleaned and stratified	Feb-May	Eastern and mid-U. S.	To 4 m	Deciduous, few branches, showy fruit, full sun	Forms thicket, occurs in dry soils
Summersweet (*Clethra alnifolia*)	Seeds	Sept-Nov	Cleaned and stratified	Feb-May	SE, MS	To 1.5 m	Deciduous, ascending stems, pubescent, shade or sun	Occurs in most soils, in woods and open areas, cultivated as ornamental
Swamp privet (*Forestiera acuminata*)[1]	Transplants	Sept-March	B&B or potted	Feb-May	SE, MS	To 8 m	Deciduous, many branches, shrubby, shade or sun	Prefers moist, bottomland type soils (silt, clay)
Swamp rose (*Rosa palustris*)[1]	Transplants	Sept-March	B&B or potted	Feb-June	MA, SE, MS	To 1 m	Deciduous, arching branches, full sun	Prefers moist soils
Tag alder (*Alnus serrulata*)[1]	Transplants, cuttings	Year-round (cut.) Sept-Mar (trans.)	In rooting medium, B&B or potted	Feb-May	NE, MA, MS, SP, MBV	To 5 m	Deciduous, rusty, pubescent, shade or sun	Occurs in moist soils, in woods or in open areas
Tartarian honeysuckle (*Lonicera tartarica*)[1]	Transplants, rootstock	Sept-March	B&B, potted or in soil beds	Feb-June	Entire U. S.	To 2 m	Deciduous, showy flowers, full sun	Cultivated as ornamental shrub
Texas huisache (*Acacia smallii*)[1]	Seeds	Aug-Oct	Dry, cool area	Jan-April	SP, MS, SW	To 5 m	Deciduous, large seed pods, full sun	Prefers dry, sandy soils, tolerates drought and salinity

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Shrubs and Small Trees (Continued)								
Thorny eleagnus (*Eleagnus pungens*)[1,3]	Transplants, cuttings	Sept-April	B&B or potted in nursery	March-June	Entire U. S.	To 4 m	Evergreen, robust, thorny, spreading, arching, full sun	Cultivated as ornamental, tolerates poor soil and salt spray
Toothache tree (*Zanthoxylum clavaherculis*)[1]	Transplants	Sept-March	B&B or potted in nursery	Feb-May	SE, FL, MS, SP	To 12 m	Deciduous, fast growing, spiny, full or partial sun	Prefers well-drained soils, occurs on dredged material in Texas and North Carolina
Turkey oak (*Quercus laevis*)[1]	Transplants, cuttings	Sept-March	B&B or potted in nursery	Feb-May	SE, MA, FL	To 10 m	Deciduous, large leathery leaves, full sun	Prefers sandy coastal areas
Wax myrtle (*Myrica cerifera*)[1,3]	Transplants	Oct-March	B&B or potted in nursery	March-June	SE, FL, MS, MA, SP	To 3.3 m	Evergreen, dense, shrubby, ascending branches, full sun	Prefers moist areas, does well on poor, sandy coastal sites
Western blackberry (*Rubus vitifolius*)	Transplants	Sept-March	B&B or potted	Feb-June	PNW, CA	To 1 m	Arching, deciduous, full sun	Occurs in dry soils, pest plant in pastures
Western chokecherry (*Prunus virginiana* var. *dimissa*)	Seeds	Aug-Sept	Cleaned and stratified	Feb-May	CA, PNW	To 8 m	Deciduous, bushy, full sun	Occurs in most soils, smells bad
Western dogwood (*Cornus occidentalis*)	Transplants	Sept-March	B&B or potted	Feb-May	PNW, CA	To 5 m	Deciduous, irregular branches, shade or sun	Occurs most soils, in woods or in open areas
Western huckleberry (*Vaccinium ovatum*)	Transplants	Sept-March	B&B or potted in nursery	Feb-June	PNW, CA	To 2.5 m	Evergreen, erect, slow growth, shade to sun	Occurs in dry woods
Wild apple (*Malus pumila*)	Seeds, transplants	Aug-Oct (seeds) Sept-Mar (trans.)	Cleaned and stratified B&B or potted	Feb-May	Entire U. S.	To 7 m	Deciduous, thorny, showy flowers, large fruit, full sun	Occurs in most soils, parent stock of all commercial apple trees
Wild black currant (*Ribes americanum*)[1]	Transplants	Sept-March	B&B or potted	Feb-June	Northern U. S.	To 1 m	Deciduous, arching, erect branches shade	Occurs in most soils
Wild cherry (*Prunus emarginata*)	Seeds	Aug-Sept	Cleaned and stratified	Feb-June	PNW, CA, SW	To 10 m	Deciduous, bitter fruit, full sun	Occurs in most soils
Wild indigo (*Baptisia leucophaea*)[1]	Seeds, transplants	Sept-Oct	Dry, cool area (seeds) B&B or potted (trans.)	Jan-March	SP, MD, SE	To 1 m	Deciduous, tumbles, seed-pods rattle, full sun	Occurs in dry soils, prefers sand or silt, tolerant of salt spray
Wild rose (*Rosa rugosa*)[1,3]	Transplants, cuttings	Sept-March	B&B or potted in nursery (trans.), in rooting medium (cuttings)	Feb-June	MA, SE, MS, SP, FL	To 5 m	Deciduous, arching branches, thorns, profuse flowers, full sun	Prefers moist soils, fast growing, tolerant of wide range of soil conditions
Wingscale (*Atriplex canescens*)	Seeds	Nov-Dec	Dry, cool place	Jan-May	MW, SW, CA	To 2.5 m	Evergreen, shrubby, much branched, full sun	Tolerates drought and wide range of soil conditions, prefers dry sandy soil
Winterberry (*Ilex verticillata*)[3]	Transplants	Sept-March	B&B or potted in nursery	March-June	SE, MD	To 5 m	Deciduous, arching, rounded crown, full sun or shade	Wide range of soil conditions, prefers moist soils
Witch hazel (*Hamamelis virginiana*)	Transplants	Sept-March	B&B or potted in nursery	Feb-May	NE, MA, SE, MS, MF, GL, MRV	To 10 m	Deciduous, shrubby, partial sun to full shade	Prefers moist soils
Yaupon (*Ilex vomitora*)[1,3]	Transplants	Oct-March	B&B or potted in nursery	Jan-April	SE, MA, MS, SP, FL	To 6 m	Evergreen, forms dense thickets, has ornamental dwarf form, full sun	Prefers sandy soils, grows on coast, tolerates salt spray
Yellow paloverde (*Cercidium microphyllum*)[3]	Transplants	Oct-March	B&B or potted in nursery	Jan-April	SW, CA	To 7 m	Deciduous, legume, shrubby, full sun	Tolerates extreme drought and some salinity, prefers sandy soil

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Large Trees								
American beech (*Fagus grandifolia*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Mar-June	NE, MA, SE, MS, GL, MRV, SP	To 30 m	Deciduous, with shallow root system, full sun	Best in moist conditions, poorly drained soils
American sycamore (*Platanus occidentalis*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Mar-June	NE, MA, SE, MS, SP, MP, NP, GL, MRV	To 30 m	Deciduous, wide spreading crown, full sun	Best in moist soils, but grows under a variety of conditions
Australian pine (*Casuarina equisetifolia*)[1,3]	Transplants	Oct-Feb	B&B or potted in nursery	Dec-April	FL, CA	To 45 m	Narrowleaf evergreen, drooping branches, full sun	Grows well in sandy soils, exotic naturalized in U. S.
Black cherry (*Prunus serotina*)[1,3]	Transplants	Aug-Oct	B&B or potted in nursery	March-June	NE, MA, SE, FL, MS, SP, MP, NP, GL	To 18 m	Deciduous, upright crown, full sun	Can be grown from seed, wood highly prized for furniture
Black cottonwood (*Populus trichocarpa*)[1,3]	Transplants, cuttings	Sept-March	B&B or potted in nursery (trans.), layered in rooting medium (cuttings)	March-June	PNW, SW, CA	To 38 m	Deciduous, fast growing, large full sun	Used for paper products, prefers moist soils, used for windbreaks and shade
Black gum (*Nyssa sylvatica*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	NE, MA, SE, FL, MS, SP, MP, NP, MRV, GL	To 27 m	Deciduous, upright crown slow growing, full sun	Prefers moist soil
Black locust (*Robinia pseudo-acacia*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Mar-June	MS, MA, MP	To 25 m	Deciduous, fragrant flowers spiny, full sun	Tolerates drought and poor soil conditions, a legume
Black walnut (*Juglans nigra*)[1,3]	Seeds, seedlings	Sept-Nov (seeds) Sept-Mar (seedlings)	Stratified (seeds), B&B or potted (trans.)	Mar-June	MA, SE, MS, SP, NP, MRV	To 30 m	Deciduous, edible, upright crown, sun to shade	Varied soil conditions, good foodplant, excellent furniture wood, grows slowly
Black willow (*Salix nigra*)[1]	Transplants, cuttings	Oct-March	B&B or potted in nursery (trans.), layered in rooting medium	Feb-July	SE, MS, MA, SP, FL	To 12 m	Deciduous, shrubby, full sun	Very fast-growing, prefers moist and flooded soils
Cow oak (*Quercus michauxii*)[3]	Seeds, transplants	Sept-Nov (seeds) Oct-March (trans.)	Stratified at 5°C, B&B or potted in nursery	March-June	MA, SE, FL, MS, SP	To 24 m	Deciduous, large edible seed, full sun to part shade	Prefers moist soils, fast growing
Eastern cottonwood (*Populus deltoides*)[1,3]	Transplants, cuttings	Sept-March	B&B or potted in nursery (trans.), layered in rooting medium (cut.)	March-June	MA, SE, GL, MRV, NP, MP, SP, MS	To 30 m	Deciduous, very fast growing full sun	Used for paper products, shade, prefers moist soil
Eastern red cedar (*Juniperus virginiana*)[1,3]	Transplants, seeds	Sept-Mar (trans.) Sept-Nov (seeds)	B&B, potted in nursery, (trans.), stratified at 5°C (seeds)	Feb-June	SE, MS, SP, MRV	To 12 m	Narrowleaf evergreen, drought tolerant, full sun	Produce commercially by tree nurseries, tolerates alkaline soil, has shrub form under stressed conditions
Eastern white pine (*Pinus strobus*)[3]	Transplants	Sept-March	B&B or potted in nursery	March-June	NE, GL, MA	To 30 m	Narrowleaf evergreen, pyramidal crown, full sun	Prefers moist sandy soil
Green ash (*Fraxinus pennsylvanica*)[1]	Transplants	Sept-March	B&B or potted in nursery	March-June	Eastern and mid U. S.	To 24 m	Deciduous, full or partial shade	Prefers moist soils, tolerates poor soil conditions
Hackberry (*Celtis occidentalis*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	SE, MS, SP, MRV, MP	To 30 m	Deciduous, large spreading crown, full sun	Tolerates alkaline and sandy soils

(Continued)

Table 5 (Continued)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Large Trees (Continued)								
Honeylocust (*Gleditsia triacanthos*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	SE, MA, GL, MRV, SP, MP, MS	To 24 m	Deciduous legume, spiny, full or partial sun	Prefers moist fertile soils
Laurel oak (*Quercus laurifolia*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Jan-March	SE, SP, MS	To 30 m	Flat topped crown, broad-leaf evergreen, full sun	Prefers moist soils, occurs on coasts
Live oak (*Quercus virginiana*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Jan-May	SE, SP, MS, MA	To 15 m	Evergreen, large spreading crown, full sun	Prefers sandy moist soils, and occurs on coasts, tolerates salt spray
Loblolly pine (*Pinus taeda*)[1,3]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-June	SE, SP, MS, MA	To 21 m	Narrowleaf evergreen, large crown, full sun	Coastal and interior plant, on sandy and silt soils, (poorly drained)
Longleaf pine (*Pinus palustris*)[1,3]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-May	MA, SE, MS, FL, SP	To 37 m	Narrowleaf evergreen, tall open crown, full sun	Prefers sandy conditions, but occurs in other soils, occurs on coast
Mockernut hickory (*Carya tomentosa*)[3]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-May	NE, MA, SE, FL, MS, MRV, SP, MP	To 25 m	Deciduous, arching branches, full or partial sun	Prefers drier soils, edible nuts, hardy, common
Paper mulberry (*Broussonetia papyrifera*)	Transplants	Sept-March	B&B or potted in nursery	March-June	Eastern U. S.	To 15 m	Deciduous, arching branches, full or partial sun	Exotic, naturalized in U. S., fast growing, forms thickets
Peachleaf willow (*Salix amygdaloides*)[1]	Transplants, cuttings	Sept-March	B&B or potted in nursery (trans.), layered in rooting medium (cuttings)	March-June	GL, NP, MP, MW	To 18 m	Deciduous, drooping branches, full sun	Prefers moist soils, grows on dredged material islands
Pecan (*Carya illinoensis*)[3]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-May	SE, MS, SP, MP	To 43 m	Deciduous, irregular crown, full sun	Prefers moist soils, but grows in wide range of soil conditions, edible nuts
Persimmon (*Diospyros virginiana*)[1]	Rootstock	Sept-March	In soil beds in nursery	Feb-June	MA, SE, FL, MS, SP, MP, MRV	To 18 m	Deciduous, drooping branches, full sun	Prefers moist, rich soils, but tolerates wide range of soil conditions, edible fruit
Pignut hickory (*Carya glabra*)	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-May	NE, MA, SE, FL, MS, MRV, SP, MP	To 23 m	Deciduous, open crown, full sun	Prefers drier soils than other hickories
Redbay (*Persea borbonia*)[1]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	MA, FL, SE, MS, SP	To 18 m	Evergreen, upright branches, full or partial sun	Often occurs in dense woods, prefers moist soils
Red maple (*Acer rubrum*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	Entire eastern U. S.	To 25 m	Deciduous, upright branches, full or partial sun	Prefers moist soils, widely used as an ornamental
Red mulberry (*Morus rubra*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	Entire eastern U. S.	To 22 m	Deciduous, rounded dense crown, full or partial shade	Prefers moist, fertile soils, edible fruit
River birch (*Betula nigra*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	MA, SE, MS, SP, MP, MRV	To 25 m	Deciduous, irregular, multistemmed, full or partial sun	Prefers moist soils, used as ornamental, common in South
Sassafras (*Sassafras albidum*)[1,3]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	NE, MA, SE, MS, SP, MP, NP, GL, MRV	To 27 m	Deciduous, spreading branches, full or partial sun	Prefers upland soils but occurs over wide range of soil conditions, forms dense thicket

(Continued)

Table 5 (Concluded)

Species (Alphabetized by Common Name)	Best Propagule Type	Collection Periods	Temporary Storage Requirements	Planting Periods	Range	Mature Height	Growth Habits	Remarks
Large Trees (Continued)								
Slash pine (*Pinus elliottii*)[1,3]	Transplants, seedlings	Oct-March	B&B or potted in nursery	Feb-May	SE, FL, MS	To 30 m	Narrowleaf evergreen, dense, rounded crown, full sun	Grows rapidly, commercial forest tree, occurs on coast
Southern red oak (*Quercus falcata*)[3]	Transplants, seedlings	Oct-March	B&B or potted in nursery	Feb-May	MA, SE, MS, SP	To 25 m	Deciduous, rounded crown, full sun	Prefers poor upland soil, used as an ornamental
Sugarberry (*Celtis laevigata*)[1,3]	Transplants	Oct-March	B&B or potted in nursery	March-June	SE, FL, MS, SP, MP	To 12 m	Deciduous, spiny, irregular crown, full sun	Prefers alkaline, well-drained soils
Sugar maple (*Acer saccharum*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	GL, NE, MRV, NP, MP, MA	To 30 m	Deciduous, rounded crown, full sun	Prefers moist soils, used for wood, furniture, as an ornamental, and for syrup
Sweetbay (*Magnolia virginiana*)[1]	Transplants	Oct-March	B&B or potted in nursery	Feb-May	MA, SE, FL, MS	To 18 m	Evergreen, shrub in north, tree in south, full sun to partial shade	Prefers moist soils, deciduous in north
Sweetgum (*Liquidambar styraciflua*)[1]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-June	MA, SE, FL, MS, SP, MRV	To 37 m	Deciduous, spreading crown, fast growing, full sun	Prefers well-drained soil tolerates many soil conditions, used for furniture
Tulip poplar (*Liriodendron tulipifera*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	Feb-June	NE, MA, SE, MS, MRV, GL	To 46 m	Deciduous, fast growing, full sun	Prefers moist soil
Water oak (*Quercus nigra*)[1,3]	Transplants, seedlings	Oct-March	B&B or potted in nursery	Feb-May	SE, MA, FL, MS, SP	To 21 m	Deciduous, rounded crown, full sun	Prefers moist soil, fast-growing, produces abundant, small, bitter acorns
White ash (*Fraxinus americana*)[1,3]	Transplants	Sept-March	B&B or potted in nursery	March-June	Eastern and mid-U. S.	To 24 m	Deciduous, upright crown, full sun	Prefers upland well-drained areas, fast-growing
White oak (*Quercus alba*)[3]	Transplants, seedlings	Sept-March	B&B or potted in nursery	Feb-June	NE, MA, SE, MS, GL, MRV, SP, MP, NP	To 30 m	Deciduous, spreading rounded crown, full sun	Tolerates wide range of soil and climatic conditions, edible acorns
White poplar (*Populus alba*)[3]	Transplants, cuttings	Sept-March	B&B or potted in nursery	Feb-June	Entire U. S.	To 24 m	Deciduous, multi-trunked, full sun	Fast-growing, exotic, naturalized over much of U. S.

Table 6

Matrix of Upland Plant Species*

Common Name	Region**													Soil Conditions									Wildlife Value				Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture					
	SE	MS	SP	MP	NP	NE	MA	PNW	SW	FL	GL	MRV	CA	MW	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding	Esthetics Value	
Grasses																														
American benchgrass						✓	✓				✓					✓	✓		✓	✓			✓		✓		✓	✓		✓
American dunegrass						✓		✓										✓	✓			✓	✓		✓		✓	✓		✓ -
Bahia grass	✓	✓					✓			✓						✓		✓				✓		✓	✓	✓	✓	?		✓ -
Barley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓				✓		✓	✓	✓	✓	?		✓
Barnyard grass	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓				✓		✓	?	✓	✓	?		
Beach panic grass	✓	✓					✓			✓						✓	✓		✓	✓		✓	✓		✓		✓	✓		✓
Beaked panic grass	✓	✓	✓	✓			✓			✓		✓				✓	✓		✓			✓		?	✓	✓	✓	?		
Big bluestem	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓		✓			✓			✓	✓	✓	✓	✓	✓	?		
Bromegrass				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓			✓	✓				✓	✓	✓	✓	✓	✓	?		
Broomsedge	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓	✓			✓				✓	✓	✓	✓		✓	✓		
Browntop millet	✓	✓					✓			✓					✓	✓		✓			✓	✓		✓	?	✓	✓			✓
Bull paspalum	✓	✓					✓			✓						✓		✓				✓		✓	✓	✓	✓			
Bushy beardgrass	✓	✓	✓			✓	✓		✓	✓		✓					✓	✓				✓		✓	✓		✓	?		
Calley Bermuda grass	✓	✓	✓							✓					✓	✓		✓				✓		✓	✓	✓	✓			✓
Coastal Bermuda grass	✓	✓	✓				✓			✓					✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓
Common Bermuda grass	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	?	✓	✓
Common reed	✓	✓	✓			✓	✓			✓	✓				✓	✓	✓	✓	✓		✓			✓	✓		✓	✓		✓
Corn	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓				✓		✓	?	✓	✓			✓
Dallis grass	✓	✓	✓				✓		✓	✓					✓	✓		✓				✓		✓	✓	✓	✓	?		✓
Deertongue	✓	✓	✓		✓	✓	✓					✓			✓	✓		✓				✓		✓	✓		✓			
European benchgrass								✓					✓						✓	✓		✓	✓		✓		✓	✓		✓
Fall panic grass	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓		
Foxtail millet	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓			✓		✓				✓		✓	?	✓	✓	?		✓
Goose grass	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓			
Green bristle grass	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓			✓
Italian ryegrass	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	?	✓	✓
Japanese millet	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓		✓	✓			✓
Johnson grass	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	?		✓
Jungle rice	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			
Large crabgrass	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			
Little hairgrass							✓	✓					✓			✓	✓	✓	✓			✓	✓		✓		✓			
Oats	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓			✓
Orchardgrass	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	?		✓
Panic grass	✓	✓	✓	✓	✓	✓	✓			✓						✓	✓	✓				✓			✓	?	✓			✓

(Continued)

* Table is coordinated with Table 5 .

** SE = southeast; MS = midsouth; SP = south plains; MP = mid plains; NP = north plains; NE = northeast; MA = mid Atlantic; PNW = northeast; SW = southwest; FL = Florida; GL = Great Lakes; MRV = Mississippi River Valley; CA = California; MW = Midwest.

Table 6 (Continued)

Common Name	Region**													Soil Conditions										Wildlife Value				Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture					
	SE	MS	SP	MP	NP	NE	MA	PRW	SW	FL	GL	MRV	CA	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding	Esthetics Value	
Grasses (Continued)																													
Pearl millet	✓		✓				✓		✓					✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			
Perennial ryegrass	✓	✓	✓							✓				✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	?		✓
Prairie cordgrass			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓	?		✓
Proso millet			✓										✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			✓
Quackgrass	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓			
Red fescue				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?	✓	✓
Redtop	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	?	✓	✓
Reed canary grass	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓
Rescue grass	✓	✓							✓				✓	✓	✓		✓				✓		✓		✓	✓			✓
Rice cutgrass	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓		✓
Rye	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓
Saltgrass	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓		✓
Saltmeadow cordgrass	✓	✓	✓			✓	✓			✓				✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓		✓
Sand dropseed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓		✓	?	✓			✓
Sea oats	✓	✓					✓			✓				✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓
Seashore bluegrass								✓					✓	✓	✓	✓		✓			✓	✓		✓		✓		✓	✓
Seashore paspalum	✓	✓								✓				✓	✓	✓		✓	✓	✓				✓	?	✓	✓		✓
Shoredune panic grass		✓	✓			✓	✓			✓				✓	✓	✓		✓			✓	✓		✓	?	✓	✓		✓
Sixweeks fescue	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Smooth crabgrass	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	?	✓			
Sorghum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Sudan grass	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Switchgrass	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	?		✓
Tall fescue	✓	✓	✓			✓	✓			✓		✓		✓	✓	✓	✓				✓		✓	✓	✓	✓	✓		✓
Texas millet	✓	✓	✓				✓			✓				✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Timothy	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓			✓		✓	✓	✓	✓	?	✓	✓
Torpedo grass		✓	✓							✓				✓	✓	✓	✓	✓		✓			✓	✓	✓	✓			✓
Vasey grass	✓	✓	✓				✓			✓			✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓			✓
Virginia dropseed		✓					✓			✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	?		✓
Walter's millet	✓	✓	✓			✓	✓			✓		✓		✓	✓	✓	✓			✓			✓	✓	✓	✓			✓
Wheat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			✓
Wild rye	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓		✓	✓	✓	✓			✓
Woolly panic grass	✓	✓					✓			✓				✓	✓	✓	✓				✓		✓	✓		✓			
Yellow bristlegrass	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓		✓	?		✓

(Continued)

Table 6 (Continued)

Common Name	Region**														Soil Conditions									Wildlife Value				Soil Stabilization and Other Soil Benefits
															pH			Salinity			Moisture			Texture					
	ISE	IMS	ISP	IMI	IMP	IRE	IMA	IPW	IMW	ISR	IPI	IGL	IMRV	ICA	IMS	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding	Esthetics Value	
Herbs																															
Alfalfa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Alsike clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓				✓	✓	✓			✓	?	✓	✓
Arrow-leaf tearthumb	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓				✓		✓	✓		✓	?		✓
Beach pea	✓	✓	✓			✓	✓	✓			✓			✓	✓	✓	✓	✓	✓	✓			✓			✓	?	✓	?		✓
Beach strawberry								✓	✓						✓	✓	✓		✓	✓			✓			✓	✓	✓			
Big filaree														✓	✓	✓	✓	✓	✓				✓		✓	✓		✓			
Bird's foot trefoil						✓	✓								✓	✓	✓	✓	✓				✓		✓	✓	?	✓			
Bittersweet nightshade					✓	✓	✓								✓	✓			✓				✓		✓	✓	✓				
Black medic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓	✓
Black nightshade	✓	✓	✓			✓	✓				✓		✓		✓	✓	✓	✓	✓				✓		✓	✓	✓				
Blackseed plantain	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓		✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓			
Bottlebrush	✓	✓	✓			✓	✓				✓		✓		✓	✓	✓	✓	✓					✓	✓	✓		✓			
Bracted plantain	✓	✓	✓			✓	✓				✓		✓		✓	✓	✓	✓	✓				✓		✓	✓		✓			
Broadleaf plantain	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓			
Buckthorn plantain	✓	✓	✓			✓	✓				✓		✓		✓	✓	✓	✓	✓				✓		✓	✓		✓			
Bush lupine								✓						✓	✓		✓	✓	✓					✓	✓	✓	?	✓	?		✓
Calandrinia														✓	✓		✓	✓	✓	✓				✓		✓		✓			✓
Camphorweed	✓	✓	✓	✓			✓		✓	✓					✓	✓	✓	✓	✓					✓		✓		✓	✓		✓
Chufa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓		✓		✓	✓	?		✓
Coast deervetch								✓						✓	✓		✓	✓	✓					✓	✓	✓	✓	✓	?		✓
Common chickweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓			✓
Common filaree	✓		✓			✓	✓	✓			✓		✓		✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	?		
Common lambsquarters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	✓		✓
Common mullein	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	?	✓		✓	?		✓
Common purslane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	?	✓		✓			✓
Common ragweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓		✓
Common spikerush	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓		✓	✓	✓	✓			✓
Common threesquare	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓
Cow pea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Crimson clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓	?	✓	✓
Croton									✓					✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			✓
Curley dock	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	?	✓			✓
Deerweed														✓		✓	✓		✓					✓	✓	✓	?	✓			✓
Dwarf spikerush	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓			✓
Filaree								✓						✓	✓	✓	✓	✓	✓				✓		✓	✓		✓			

(Continued)

Table 6 (Continued)

Common Name	Region**													Soil Conditions										Wildlife Value				Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture					
	1	2	3	4	5	6	7	8	9	10	11	12	13	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding	Esthetics Value	
Herbs (Continued)																														
Flat pea					✓	✓	✓			✓	✓			✓	✓	✓	✓				✓		✓	✓	?	✓			✓
Flowering spurge	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓					✓	✓	✓		✓			✓
Giant ragweed	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	?		✓
Goosefoot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓			
Hardstem bulrush	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	?		✓
Hairy vetch	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	?	✓			✓
Hemp sesbania	✓	✓	✓			✓		✓	✓					✓	✓	✓	✓				✓		✓	✓		✓			✓
Hop clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓			✓
Horse nettle	✓	✓	✓			✓	✓			✓	✓	✓		✓	✓		✓				✓	✓	✓	✓	✓				
Horseweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓		✓
Japanese clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	?		✓
Jerusalem artichoke	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓				✓		✓	✓	✓				
Korean clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			✓
Ladino clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Ladysthumb	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓		✓	✓	✓	✓			
Lespedeza	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓
Lupine							✓	✓				✓			✓	✓	✓					✓	?	✓		✓	?		✓
Malta starthistle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	?	✓			
Maple-leaf goosefoot	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓				✓	✓	✓	✓		✓			
Marsh pea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓		✓
Marsh pepper	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	?		
Maximillian's sunflower	✓	✓	✓	✓	✓		✓	✓						✓	✓	✓	✓				✓		✓	✓		✓	?	✓	✓
Mexican tea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	?	✓	✓		
Musk filaree									✓					✓	✓	✓	✓					✓	✓	✓		✓			
Narrowleaf vetch	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Nodding smartweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓		✓
Nutsedge			✓	✓	✓				✓					✓	✓	✓	✓					✓	✓	✓	?	✓			
Olney threesquare	✓	✓	✓		✓	✓			✓			✓		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓		✓
Orache	✓	✓	✓		✓	✓			✓			✓		✓	✓	✓		✓	✓		✓		✓	✓	?	✓			
Patridge pea	✓	✓	✓		✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓	✓
Pennsylvania smartweed	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓		
Pickleweed					✓		✓	✓				✓		✓	✓	✓	✓			✓			✓	✓		✓			
Pokeberry	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			
Prostrate knotweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓			✓
Prostrate pigweed					✓	✓				✓	✓			✓	✓	✓	✓				✓		✓	✓		✓			

(Continued)

Table 6 (Continued)

Common Name	Region**														Soil Conditions										Wildlife Value			Soil Stabilization and Other Soil Benefits
															pH			Salinity			Moisture			Texture				Esthetics Value	
	ISE	IMS	ISP	IMP	INP	INE	IMA	IPM	ISM	IPL	IGL	IMW	ICA	IMW	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding	
Herbs (Continued)																												
Prostrate spurge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓		
Purple nutsedge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓		
Purple vetch	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓
Red clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓				✓		✓	✓	✓	✓		✓
Redroot pigweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			✓	?	✓		✓
Reseeding soybean	✓	✓													✓	✓	✓	✓				✓		✓	✓	✓	✓		
River bulrush	✓					✓	✓						✓		✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	
Saltmarsh bulrush		✓	✓					✓					✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	?	✓
Saltwort	✓					✓	✓			✓					✓	✓	✓	✓	✓			✓		✓	✓		✓		✓
Sea blite	✓	✓	✓			✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	?	✓
Sea ox-eye	✓	✓	✓				✓			✓					✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓
Seashore lupine								✓					✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	?	✓		✓
Seaside dock			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		?	✓	✓	✓		
Seaside goldenrod	✓	✓	✓				✓			✓					✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓	
Seaside plantain	✓	✓	✓			✓	✓	✓		✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓		
Sericea lespedza	✓	✓	✓	✓			✓			✓		✓			✓	✓	✓	✓				✓		✓	✓	✓	✓	?	✓
Sheep sorrel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓				✓		✓	✓		✓		✓
Showy tick-trefoil	✓	✓			✓	✓				✓	✓	✓			✓	✓	✓	✓				✓		✓	✓	✓	✓		
Silverleaf croton	✓	✓								✓					✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		
Southern bulrush	✓	✓								✓			✓		✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	?	✓
Southern ragweed	✓	✓	✓												✓	✓	✓	✓				✓	✓	✓	✓		✓	?	
Soybean	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓
Spotted burclover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓		✓
Spotted spurge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓		✓		
Squarestem spikerush	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓		
Sunflower	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓				✓		✓	✓		✓		
Schweinitz's nutsedge				✓	✓	✓					✓	✓			✓	✓	✓	✓			✓	✓		✓	✓	✓	✓		
Tansy mustard	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	✓	
Tropic croton	✓	✓	✓				✓			✓		✓			✓	✓	✓	✓				✓		✓	✓	✓	✓		
Tumbleweed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓		
Virginia pepperweed	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	✓	
Western ragweed			✓	✓	✓	✓		✓		✓		✓	✓		✓	✓	✓	✓				✓	✓	✓	✓		✓	?	
White clover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓				✓		✓	✓	✓	✓	?	✓
White sweetclover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?	✓
Wild bean	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓
Wild buckwheat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓		

(Continued)

Table 6 (Continued)

Common Name	Region** SE	MS	SP	MP	NP	NE	MA	PNW	SW	FL	GL	MRV	CA	MW	Soil Conditions: pH Acid	pH Neutral	pH Alkaline	Salinity Fresh	Salinity Brackish	Salinity Saline	Moisture Wet	Moisture Moist	Moisture Dry	Texture Fine	Texture Coarse	Wildlife Value Food	Cover	Nesting/ Breeding	Esthetics Value	Soil Stabilization and Other Soil Benefits
Herbs (Continued)																														
Wild sensitive pea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓	✓
Wild strawberry	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓					✓	✓	✓	✓	✓				
Woolly croton	✓	✓	✓	✓			✓					✓			✓	✓	✓	✓				✓		✓	✓	✓	✓	?		
Woolly indianwheat			✓	✓	✓									✓		✓	✓	✓					✓	✓	✓		✓			
Yellow starthistle							✓	✓				✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			
Yellow sweetclover	✓	✓				✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓				✓
Vines																														
American bittersweet			✓			✓	✓				✓	✓		✓	✓	✓	✓	✓				✓		✓	✓	✓				
Bamboo vine	✓	✓	✓				✓			✓					✓	✓	✓	✓				✓		✓	✓	✓				
Beach morning glory	✓	✓	✓			✓	✓			✓	✓	✓			✓	✓	✓		✓	✓			✓		✓		✓		✓	✓
Common greenbrier	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			
Crossvine	✓	✓								✓		✓			✓	✓	✓	✓				✓		✓	✓		✓			
Foxgrape	✓					✓	✓					✓			✓	✓	✓	✓				✓		✓	✓	✓	✓			
Fringed catbrier	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓		✓	✓		✓			
Frost grape	✓					✓	✓							✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Japanese honeysuckle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Kudzu	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓
Lanceleaf greenbrier	✓	✓	✓							✓					✓	✓	✓	✓				✓	✓	✓	✓		✓			
Muscadine grape	✓	✓	✓	✓			✓			✓					✓	✓	✓	✓				✓		✓		✓	✓			
Peppervine	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓			
Sawbrier	✓	✓	✓		✓	✓				✓	✓	✓			✓	✓	✓	✓				✓	✓		✓		✓			
Summer grape	✓	✓								✓					✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			
Supplejack	✓	✓	✓							✓					✓	✓	✓	✓				✓		✓	✓		✓			
Virginia creeper		✓	✓	✓	✓	✓	✓					✓			✓	✓	✓	✓				✓	✓	✓	✓		✓			
Wild bamboo	✓	✓								✓					✓	✓	✓	✓				✓		✓	✓		✓			
Shrubs and Small Trees																														
American elderberry	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	?	✓	
American hornbeam	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	?	✓	?		
American plum	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓	
Arrowwood viburnum	✓	✓													✓	✓	✓	✓				✓		✓	✓	✓	✓			
Autumn olive	✓	✓	✓				✓			✓					✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bayberry						✓	✓								✓	✓	✓	✓	✓			✓	✓	?	✓		✓	✓	✓	✓
Beach plum						✓	✓								✓	✓	✓	✓	✓			✓	✓	?	✓	✓	✓			✓
Bearberry					✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓					✓	?	✓	✓	✓			✓
Beautyberry	✓	✓					✓			✓					✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	
Bicolor lespedeza	✓		✓				✓			✓					✓	✓	✓	✓				✓	✓	✓	✓	✓	✓			✓

(Continued)

(Sheet 6 of 11)

Table 6 (Continued)

Common Name	Region**													Soil Conditions								Wildlife Value			Esthetics Value	Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture					
	NE	NC	SE	SC	NRP	NW	SW	PW	SR	RL	GL	MRV	CA	SW	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding		
Shrubs and Small Trees (Continued)																														
Black raspberry	✓		✓	✓		✓	✓								✓	✓	✓	✓				✓		✓	✓	✓	✓	?		
Blue brush								✓					✓		✓	✓	✓	✓					✓		✓	✓	✓			
Blue elderberry								✓	✓				✓		✓	✓	✓	✓				✓		✓	✓	✓	✓			
Brazilian peppertree										✓					✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓
Brewer saltbrush													✓	✓	✓	✓	✓		✓	✓			✓	✓	✓		✓			✓
Buffaloberry					✓	✓	✓		✓		✓				✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Bush lupine								✓					✓		✓	✓	✓	✓				✓	✓	✓	✓		✓	?		✓
California blackberry								✓					✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	?		✓
California buckthorn								✓					✓		✓	✓	✓	✓					✓	✓	✓		✓			✓
Canadian serviceberry	✓					✓	✓								✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	?		
Carolina ash	✓	✓	✓	✓			✓			✓					✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	?	✓	✓
Carolina rose	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓		✓	✓	✓	✓
Cascara buckthorn								✓					✓		✓	✓	✓	✓				✓		✓	✓		✓	?		
Cherry laurel	✓	✓					✓								✓	✓	✓	✓				✓		✓	✓		✓	?	✓	
Chickasaw plum	✓	✓	✓				✓								✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
Common buckthorn	✓	✓	✓							✓					✓	✓	✓	✓				✓		✓	✓		✓			
Common chokecherry		✓		✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	?		✓
Common deerberry	✓	✓				✓	✓			✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓	✓			
Common juniper	✓	✓								✓	✓					✓	✓	✓				✓		✓	✓		✓	✓	✓	✓
Common sweetleaf	✓	✓					✓								✓	✓	✓	✓				✓		✓	✓	✓	✓			
Crabapple	✓	✓					✓			✓					✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	
Dahoon	✓	✓								✓					✓	✓	✓	✓	✓			✓	✓		✓		✓	✓	✓	
Downy serviceberry	✓	✓													✓	✓	✓	✓					✓	✓	✓	✓	✓			
Eastern hophornbeam	✓	✓	✓	✓		✓	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓		✓	✓		
Elderberry (glauca)								✓	✓				✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓			
Elderberry (callicarpa)								✓					✓		✓	✓	✓	✓					✓	✓	✓	✓	✓			
Evergreen blackberry	✓	✓				✓	✓			✓	✓	✓			✓	✓	✓	✓					✓		✓	✓	✓	✓	✓	✓
Firethorn	✓	✓	✓				✓			✓					✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flowering dogwood	✓	✓	✓			✓	✓			✓	✓	✓			✓	✓		✓				✓	✓	✓	✓		✓	✓	✓	
Gallberry	✓	✓				✓	✓			✓					✓	✓	✓	✓				✓	✓	✓	✓			✓		
Gray dogwood	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓		✓				✓		✓	✓	✓	✓			
Ground blueberry	✓	✓					✓								✓	✓	✓	✓				✓		✓	✓	✓	✓			
Groundsel tree	✓	✓	✓			✓	✓								✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓		✓
Halberd-leaved willow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓	✓	✓	
Hibiscus	✓	✓	✓			✓	✓			✓					✓	✓	✓	✓	✓		✓	✓		✓	✓		✓		✓	

(Continued)

Table 6 (Continued)

Common Name	Region**													Soil Conditions											Wildlife Value				Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture				Nesting/	Esthetics	
														Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Breeding	Value	
Shrubs and Small Trees (Continued)																													
Highland blueberry	✓	✓				✓	✓			✓				✓		✓					✓		✓	✓	✓	✓			
Hollyleaf cherry									✓					✓		✓		✓				✓		✓		✓			✓
Honey mesquite			✓					✓						✓		✓		✓				✓		✓		✓	✓		✓
Hooker's willow							✓				✓			✓		✓		✓		✓	✓			✓		✓	?		✓
Japanese lespedeza	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓			✓		✓	✓	✓	✓		✓	✓
Low blueberry	✓	✓					✓							✓		✓		✓			✓		✓	✓	✓	✓			
Maglelleaf viburnum	✓	✓					✓							✓		✓	✓	✓			✓		✓	✓	✓	✓	?		
Marsh elder	✓	✓	✓			✓	✓			✓				✓		✓	✓	✓		✓	✓			✓		✓	✓		✓
Mountain blackberry						✓	✓				✓	✓		✓		✓	✓				✓		✓	✓	✓	✓	✓		✓
Multiflora rose	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓			✓		✓	✓	✓	✓	✓	✓	✓
Myrtle oak									✓					✓		✓	✓	✓			✓		✓	✓	?	✓	✓	✓	
Northern bayberry						✓	✓							✓		✓	✓	✓			✓			✓		✓	✓	✓	✓
Oleander		✓						✓	✓					✓		✓	✓	✓			✓	✓		✓		✓	✓	✓	✓
Pacific bayberry							✓				✓			✓		✓	✓	✓			✓	✓	✓	✓		✓	?		
Pacific dogwood							✓				✓			✓		✓	✓				✓		✓	✓	✓	✓			
Pacific wax myrtle							✓				✓			✓		✓	✓	✓			✓		✓	✓		✓			✓
Pacific willow							✓				✓			✓		✓	✓			✓	✓		✓	✓		✓	✓		✓
Poison ivy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓			✓		✓	✓	✓	✓	✓		
Possumhaw	✓	✓	✓	✓			✓		✓	✓	✓			✓		✓		✓			✓		✓	✓	✓	✓	✓	✓	
Possumhaw viburnum	✓	✓					✓		✓					✓		✓		✓			✓		✓	✓		✓	?		
Purple osier willow						✓	✓			✓				✓		✓		✓		✓	✓		✓	✓		✓		✓	✓
Pussy willow					✓	✓			✓					✓		✓		✓		✓	✓		✓	✓	✓	✓	?	✓	✓
Quail brush								✓						✓		✓		✓				✓		✓		✓	✓		✓
Red alder							✓				✓			✓		✓		✓			✓		✓	✓		✓	?		✓
Red buckeye	✓	✓	✓											✓		✓		✓			✓		✓	✓	✓	✓	✓		
Red osier dogwood					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Riverflat hawthorn	✓	✓					✓							✓		✓		✓			✓	✓	✓	✓	✓	✓	?		✓
Rough-leafed dogwood	✓	✓	✓	✓	✓		✓							✓		✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Russian olive	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓			✓	✓	✓	✓		✓	✓	✓	✓
Rusty blackhaw	✓	✓					✓		✓					✓		✓		✓			✓	✓	✓	✓	✓	✓			
Salal							✓				✓			✓		✓		✓			✓		✓	✓		✓	?	✓	
Salmonberry							✓							✓		✓	✓	✓			✓		✓	✓	✓	✓		✓	✓
Saltbush										✓				✓		✓	✓				✓	✓		✓		✓			
Saltcedar		✓	✓				✓		✓				✓	✓		✓	✓	✓			✓	✓	✓	✓		✓	✓	✓	✓
Sandbar willow			✓	✓		✓				✓	✓		✓	✓		✓	✓			✓	✓		✓	✓		✓	✓		✓

(Continued)

Table 6 (Continued)

Common Name	Region**														Soil Conditions											Wildlife Value			Esthetics Value	Soil Stabilization and Other Soil Benefits
															pH			Salinity			Moisture			Texture				Nesting/		
	SE	MS	SP	MP	NP	NE	MA	PNW	SW	FL	GL	NGV	CA	NW	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Breeding		
Shrubs and Small Trees (Continued)																														
Sand blackberry	✓						✓			✓					✓	✓	✓	✓					✓		✓	✓	✓	?		✓
Sand pine		✓								✓					✓	✓	✓	✓	✓			✓	✓		✓		✓	?		✓
Sawtooth oak	✓	✓	✓							✓					✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓
Scotch broom								✓							✓	✓	✓	✓				✓		✓	✓		✓	✓	✓	✓
Sharp-tooth blackberry	✓	✓					✓			✓		✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓
Shining sumac	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Shore pine								✓					✓		✓	✓	✓	✓				✓	✓	✓	✓		✓	?		✓
Shrub verbena	✓	✓	✓							✓					✓	✓	✓	✓	✓			✓		✓	✓		✓	✓	✓	✓
Silky dogwood	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓		✓				✓		✓	✓	✓	✓			
Silky willow						✓	✓				✓	✓			✓	✓	✓	✓			✓	✓		✓	✓		✓	✓		✓
Sitka alder								✓							✓	✓	✓	✓				✓		✓	✓		✓	✓		✓
Smooth sumac	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?		
Southern bayberry	✓	✓	✓				✓			✓					✓	✓	✓	✓	✓			✓		✓	✓		✓	✓		✓
Southern dewberry	✓	✓	✓							✓					✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Sparkleberry	✓	✓	✓				✓								✓	✓	✓	✓					✓	✓	✓	✓	✓			
Squaw huckleberry	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓	✓			
Staghorn sumac	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓	✓	?		✓
Summersweet	✓	✓													✓	✓	✓	✓					✓	✓	✓		✓		✓	
Swamp privet	✓	✓													✓	✓	✓	✓			✓	✓		✓		✓	✓	✓		✓
Swamp rose	✓	✓					✓								✓	✓	✓	✓				✓		✓	✓		✓		✓	
Tag alder		✓	✓			✓	✓					✓			✓	✓	✓	✓				✓		✓	✓		✓	?		✓
Tartatian honeysuckle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓		✓	✓
Texas huisache		✓	✓						✓						✓	✓	✓	✓	✓			✓	✓		✓		✓	✓		✓
Thorny eleagnus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Toothache tree	✓	✓	✓							✓					✓	✓	✓	✓						✓	✓		✓	✓		
Turkey oak	✓	✓								✓					✓	✓		✓				✓	✓	✓	✓	✓	✓	?	✓	✓
Wax myrtle	✓	✓	✓				✓			✓					✓	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓
Western blackberry								✓					✓		✓	✓	✓	✓				✓		✓	✓	✓	✓	?		✓
Western chokeberry								✓					✓		✓	✓	✓	✓				✓		✓	✓	✓	✓	?		
Western dogwood								✓					✓		✓	✓	✓	✓				✓	✓	✓	✓		✓	?	✓	
Western huckleberry								✓					✓		✓	✓	✓	✓				✓		✓	✓	✓	✓			
Wild apple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	?	✓	
Wild black currant					✓	✓					✓	✓			✓	✓	✓	✓				✓		✓	✓	✓	✓			
Wild cherry								✓	✓				✓		✓	✓	✓	✓				✓		✓	✓	✓	✓	?		
Wild indigo	✓	✓	✓												✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓		
Wild rose	✓	✓	✓				✓			✓					✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓

(Continued)

Table 6 (Concluded)

Common Name	Region**													Soil Conditions										Wildlife Value			Esthetics Value	Soil Stabilization and Other Soil Benefits
														pH			Salinity			Moisture			Texture						
	1	2	3	4	5	6	7	8	9	10	11	12	13	Acid	Neutral	Alkaline	Fresh	Brackish	Saline	Wet	Moist	Dry	Fine	Coarse	Food	Cover	Nesting/ Breeding		
Large Trees (Continued)																														
Sassafras	✓	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓	✓	✓				✓	✓	✓	✓		✓	✓	✓	✓
Slash pine	✓	✓							✓					✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓
Southern red oak	✓	✓	✓				✓							✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
Sugarberry	✓	✓	✓	✓					✓					✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	
Sugar maple				✓	✓	✓	✓				✓	✓		✓	✓	✓	✓				✓		✓	✓	✓		✓	✓	
Sweetbay	✓	✓				✓			✓					✓	✓	✓	✓				✓		✓	✓	✓	✓			
Sweetgum	✓	✓	✓			✓			✓		✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	
Tulip poplar	✓	✓				✓	✓				✓	✓		✓	✓	✓	✓			✓	✓		✓	✓		✓	✓	✓	
Water oak	✓	✓	✓			✓			✓					✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓
White ash	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	?	✓	✓		
White oak	✓	✓	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
White poplar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓	✓	✓	

Table 7

Criteria for Selection of Propagule Type

Availability and cost. These two factors are closely related. Seeds, cuttings, sprigs, root stocks, tubers, rhizomes, seedlings, and grown plants are all forms of propagules, and are listed in ascending order for ease and costs of obtaining them. When more than one propagule type is available for a species, the less expensive, more easily handled one should be selected. However, if seeds are not available at the time they are needed, or if the species selected is a poor producer of seeds, such as saltmeadow cordgrass, a more expensive form will have to be used.

Ease of collection and handling. The form of propagule selected should be easy to locate, obtain, and handle. Many species are available from commercial or Government seed sources. If they are not available, it may be difficult to find enough seeds, harvest the seeds, or treat the seeds in the best manner, since noncommercial species often have unknown requirements. Vegetative propagules present other problems. The plant material is bulky and requires careful and laborious handling (potting, burlapping, wrapping). More time is necessary to collect vegetative propagules than seeds, and high amounts of labor, equipment, and time are necessary to do the planting.

Ease of storage. Because of their small bulk, seeds are usually stored with little difficulty. Storage techniques influence germination success and vary with the species. Follow techniques in Coastal Zone Resources Division (1978) and references such as U. S. Department of Agriculture (1961). Techniques include storage dry or wet, in cold rooms (5°C) or at room temperature, treated or untreated with insecticides and fungicides, in airtight containers or on open racks. Vegetative propagules again present a greater problem, since more space for storage is needed, labor is necessary for maintenance, and the plants may have to be rehandled and put into new containers for planting.

Ease of planting. Seeds can be broadcast or planted in rows by machine or by hand. However, vegetative propagules must be transplanted by hand, if large or fragile, or by a combination of hand and machine labor by a special transplanter, if small.

Occurrence of disease. Occasionally a seed or plant source will be infected with fungus or plant virus which will limit propagule selection. Do not take propagules from diseased stock unless no other source is available. Disease lowers the viability of a plant and will likely reduce its chances for successful propagation.

Need for rapid establishment. If it is necessary to vegetate the site immediately, for example to protect the soil, maximum cover can usually be obtained quickest with vegetative propagules regardless of the species. But, in the case of rapidly growing annuals such as corn, millet, and wheat, seeds result in a fast cover. Trees and shrubs are most often transplanted as seedlings or as 1- to 5-year-old plants, since growth from seeds is slow and the loss from plant competition and natural invasion is high.

Table 8

Guidelines for Collecting and Storing Seeds

1. Locate a plant stock which is readily accessible, fairly abundant, free of disease, and which is producing a current season crop of seeds. Several locations may be necessary for collection of the numbers needed and to avoid damage to the stand.

2. Collect seeds when they are mature but not yet falling. Depending upon the species, this may be from April until November.

3. Use field collection methods compatible with species being collected:

   a. Multiseeded heads such as most grasses, sumacs, etc., are usually gathered by cutting off the entire seed head with pruning shears and letting it fall into a container. The seeds are thrashed out of the heads in the laboratory.

   b. Single seeds such as live oak acorns or yaupon berries may be collected by picking.

   c. Pods from legumes should be collected when they are dry but not yet shedding from the plant.

4. Upon return from the field, store the seeds until time to plant. Storage time is usually necessary to complete the afterripening, or breaking of dormancy, that is a characteristic of many species. Most upland species should be stored according to specific directions:

   a. Clean chaff and infertile seeds from seed lots by sieving, thrashing, and/or blowing.

   b. Test seed viability and germination at the beginning of storage and prior to planting, as the percentages may change over a period of weeks. This information is needed to calculate the number of seeds that will need to be planted for desired coverage. Tetrazolium is one of the more common tests for viability. Refer to Maguire and Heuterman (1978) and U. S. Department of Agriculture (1961) for other methods.

   c. Store seeds according to known information (Table 5 or local Soil Conservation Service data). If this information is not available, store the seeds in a dry, cool (5 to 10°C) place in containers with adequate ventilation. Seeds may require treatment with an insecticide to prevent weevil damage during storage or with a fungicide to minimize spoiling.

   d. Seeds are subject to numerous fungi, smuts, blights, and rots, and weevils and beetles during storage. Cold, dry storage conditions will do much to control both diseases and insects. Treatment with fungicides such as Captan will control most diseases. Treatment with insecticides such as malathion will help control insect damage. Follow treatment directions given for individual chemicals carefully to avoid decreasing seed viability.

(Continued)

Table 8 (Concluded)

e. Seeds of some species may require special treatment to induce germination or to insure vigorous seedling growth. For example, partridge pea seeds require heating with steam to break down germination inhibitors. Others may require treatment with giberillin or other growth stimulators, or scarification of seed coats. Seeds of legumes such as alfalfa require inoculation with nitrogen-fixing Rhizobia sp. bacteria to induce more rapid growth. The best time for these specific treatments is after storage and just prior to planting.

Table 9

Guidelines for Collecting and Storing Vegetative Propagules

1. Locate a source that is readily accessible, fairly abundant, and disease-free.

2. Collect propagules while the plant is dormant, if possible, to minimize shock and increase chances for survival. Alternative times are at the beginning or the end of the growing season. If possible, do not collect a fruiting or flowering plant, as it is already under stress from the effort of reproduction and will go into shock more quickly.

3. Field collection techniques will vary depending upon the type of vegetative propagule (root stock, rhizome, tuber, cutting, seedling, or transplant) desired:

   a. Root stock is obtained by digging an entire plant and cutting off the top to within 10 cm of the root system. The propagule is best divided at this time into smaller clumps of root stock, if desired and if the plant will tolerate that much stress. New growth will be generated from the old root system.

   b. Rhizomes should be dug, the tops cut off to within 10 cm of the rhizomes, and the rhizomes divided. Care should be taken to keep a growth point (meristematic tissue) on each rhizome to insure new growth.

   c. Tubers should be dug at the end of the growing season in order to obtain the new crop for replanting. They may be harvested mechanically with plows to loosen them from the soil or with hand tools to pick them out of the soil.

   d. Cuttings are usually taken only in the case of trees and shrubs but can be made for some herbaceous species. Cuttings are made in or just under a leaf node about 15 to 20 cm from the growth point of the stem and are always taken from a seasoned stem (no new growth evident). Dormant deciduous cuttings are made from plants after the leaves drop. Evergreen or actively growing deciduous cuttings are made with mature leaves present. All but 3 to 5 leaves near the growth tip should be removed to decrease stress from respiration loss. Cuttings are usually benefited by dipping the cut end in a rooting hormone such as Rootone to hasten callus and root formation.

   e. Seedlings are obtained by digging new growth offshoots of existing plants and separating them from the parent stock. This is desirable because the entire propagule is new growth and ready to grow rapidly upon transplanting, and because the top shoots are retained, which often lessens shock to the propagule.

   f. Transplants are entire plants which are dug, removed, and transplanted to the new site. This propagule type is best for trees and shrubs. It is best to dig a ball of soil with the transplant to minimize root loss and disturbance. Bare root stock may be

(Continued)

moved when the plant is dormant, but this stock at other times of the year will almost always die from shock. An evergreen should not be moved as bare root stock.

4. The propagule should be as large as is practical to work with. In general, a 7- to 10-cm clump of root stock, rhizome, or seedling is an easily handled size. Tubers should be mature when harvested and of as large a size as is available. An example is chufa, which should be harvested to a depth of 40 cm and brown-colored tubers of at least 0.5 cm in diameter taken. Transplants should be 1 to 5 years of age and from 30 to 150 cm high for most species. Larger transplants survive poorly since a large portion of the root system is left in the soil when the transplants are removed.

5. After digging the propagule, immediately place it into a plastic bag to retain moisture and minimize shock. A container of water is adequate but harder to handle in quantity. If field collection is going to take a day or more, sprinkle water on the plant material inside the bags to prevent it from drying out.

6. Upon return from the field, treat propagules as follows:

   a. Immediately pot root stock, rhizomes, seedlings, and transplants in all-purpose potting soil (one part soil, one part sand, one part vermiculite, one part bark chips) either in a well-drained container such as a peat pot or Styrofoam cup or into a soil bed. For short periods of time, propagules may be planted in sand only but will require fertilization. Water as soon as a bed or group of pots is planted and placed in the holding area, to remove air pockets around the root systems. Plant just deep enough to cover the root system and place only one propagule in a pot. Peat pots are desirable because they are actually compressed mulch and the entire plant may be planted in the pot. Their chief disadvantage is that after a period of several months roots grow through the sides and become embedded in the surrounding holding material, and the pots decompose rapidly. Styrofoam cups are handy and last longer, but the plants must be removed from them before transplanting. Another pot material is papier mache, which is also biodegradable like a peat pot. Container planting is recommended to decrease shock from transplanting.

   b. Tubers are handled similarly to seeds, but they often are stored moist and in a cold room to break dormancy before planting. Tubers may be planted like seeds unless they are too large.

   c. Dormat deciduous cuttings are stored wrapped in moist peat moss or buried in sand in a dark, cool room (5 to 10°C) until time to plant. Evergreen or actively growing deciduous cuttings are not stored but are placed in a propagation room in moist sand or rooting medium for rooting. Cuttings either are transplanted immediately to the field site to be rooted or are rooted in a propagation room and planted as transplants.

(Continued)

Table 9 (Concluded)

7. Plant material must be maintained by an active watering and fertilization program until time to move it to the field site. This will require manpower and an adequate storage area. Fertilize each gallon-sized* pot with 2 tablespoons of all-purpose fertilizer once each month. If the propagules are stored outside under dormant conditions (winter), do not fertilize them since the plants can only use the fertilizer when actively growing.

8. During storage, plant material will be subject to disease and insect damage. Watch for signs of these problems and treat accordingly.

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* Gallon is a standard stock size and has no exact metric equivalent.

Table 10

Protective and Retention Structures and Their Applicability

Structure	Function	Maximum Feasible Height	Special Foundation Requirements	Erosion Resistance	Duration	Relative Cost	Remarks
Sand dike (hydraulically placed)	Protection and retention	Foundation-dependent	None	Depends on material used	Long	Low	Build from coarsest material available
Sand dike (end-dumped)	Protection and retention	Foundation-dependent	None	Depends on material used	Long	Low	Land borrow may be available
Retaining wall (cantilevered)	Protection and retention	4.5 m	Firm bottom	Good	Long	Moderate to low	Wall usually constructed with sheet-pile; reclamation of piling recommended
Retaining wall (anchored)	Protection and retention	12.0 m	Select backfill	Good	Long	Moderate to high	Construction usually performed by floating plant; adequate operating depth required
Coffer dam	Protection and retention	6.0 m	None	Good	Long	High	Limited applicability in habitat development
Gabion	Protection and retention	3.0 m	None	Susceptible to scour	Intermediate	Moderate	Requires availability of small rock
Fabric bags	Protection and retention	Varies	None	Good	Long if concrete filled, short if sand filled	Low	Susceptible to vandalism; degrade in 2 to 3 years
Revetment	Protection	--	None	Good	Long	Low to high	Used in conjunction with dikes
Offshore sill	Protection	--	None	Moderate	Long	Low to medium	Causes waves to break before reaching substrate
Floating breakwater	Protection	--	None	--	Intermediate	Low	Reduces wave heights
Groin	Protection	--	None	Good	Long	Low to high	Causes waves to break before reaching substrate

Table 11

Operational Characteristics of Dredges

Type of Dredge	Loss of Liquid	Percent Solids in Slurry by Weight*	Relative Turbidity Caused	Ability To Operate in Open Water	Vessel Draft m	Approximate Range of Production Rates m^3/hr	Dredging Depths m		Maximum Wave Height m	Lateral Dredging Accuracy** m
							Minimum	Maximum		
Dipper	High	In situ	High	Yes†	--††	23-460	0‡‡	15	<0.9#	0.15
Clamshell or grab	High	In situ	High	Yes†	--††	23-460	0‡‡	45§	<0.9#,##	0.3
Suction	Low	10-15	Low	Yes†	1.5-2.0	19-7640‡	1.5-2.0	15-18§§	<0.9	0.6-0.9
Dustpan	Low	10-20	Average	No	1.5-4.2	19-7640‡	1.5-4.2	15-18§§	<0.9	0.6-0.9
Cutterhead	Low	10-20	Average	Yes†	0.9-4.2	19-7640‡	0.9-4.2	3.6-19.5§§	<0.9	0.6-0.9
Hopper	Low	10-20	Average	Yes	3.6-9.3	380-1530‡	3.0-8.4	19.5§§	<2.1	3.0
Mud Cat	Low	10-40	Low	No	0.5	46-115	0.5	4.5	<0.3	0.15
Pneuma	Low	Up to 80	Low	Yes†	--††	46-298	0‡‡	45§	<0.9#,##	0.3
Handheld vacuum	Low	5-10	Low	Yes	--††	7.5	0‡‡	30	--#	<0.15

* Percent solids could theoretically be 0, but these are normal working ranges. Percent solids = weight of dry sediment ÷ weight of wet slurry.

** Vertical accuracies are generally within 0.3 m.

† Limited operation in open water possible, depending on hull size and type and wave height.

†† Depends on floating structure; if barge mounted, approximately 1.5- to 2.0-m draft.

‡ Total flow of water pumped per hour; complete production rate obtained by multiplying flow by percent solids in slurry.

‡‡ Zero if used alongside of waterway; otherwise, draft of vessel will determine.

§ Demonstrated depth; theoretically could be used much deeper.

§§ With submerged dredge pumps, dredging depths have been increased to 30 m or more.

Depends on supporting vessel; usually barge-mounted.

Theoretically unaffected by wave height; digging equipment not rigid.

Table 12

Construction Equipment Available for Habitat Development*

Operation	Equipment Used		
	On Land	In Shallow Water	Offshore
Clearing foundation	Bulldozer, dragline	Dragline on timber mats	Floating dragline
Obtaining material	Bulldozer Dragline Truck transport from borrow area	Clamshell Dragline on pontoons Dragline on timber mats Hydraulic dredge and pipeline Truck transport from borrow area	Barged dragline Clamshell Hydraulic dredge and pipeline Barged transport from borrow area
Placing material	Dragline Bulldozer Hydraulic fill** End-dumping from trucks	Dragline on pontoons End-dumping from trucks Hydraulic fill	Bottom-dump scows Barge with conveyor Hydraulic fill** Barged dragline
Shaping and compacting†	Bulldozer Scrapers Haul traffic	Bulldozer Haul traffic Dragline	Bulldozer Dragline
Placing riprap	--	Clamshell	Barged clamshell

* Modified from Johnson and McGuinness (1975). Refer to Willoughby (1977) for use of construction equipment on fine-grained dredged material.

** Various hydraulic fill procedures have been used, including: bleeder pipe (on land, shallow water); direct discharge (on land); spillbarge (on water), virgin clay source used; and floating swing discharge line.

† Compaction normally carried out on 0.3-m added layers of fill on emergent portions of dike.

Table 13

Disposal Area Operation Guidelines*

Position the discharge pipeline so that the coarse fraction of the dredged slurry will be deposited where it can be put to best use.

Facilitate material placement operations in water by using:

- Additional pipeline flotation.
- Spillbarge.
- Floating swing-discharge line.

Facilitate material handling operations on land by using:

- Wye branches and valves with pipeline.
- Fill trafficability improvements.
- Whooping crane.
- Low-ground-pressure vehicles.
- Dragline with deadman and pulley.

Lessen scouring during deposition by using energy dissipators such as baffle plates, bleeder pipes, and pipe distribution systems.

Maintain adequate retention time for sedimentation in confined disposal areas by using:

- Properly designed weirs with adjustable crest elevations.
- Cross and spur dikes, if required.

Divide confined disposal area into cells so that:

- Flexibility in receiving incremental fill volumes is increased.
- Accuracy of settlement prediction in filled cells is improved.
- New habitat can be developed incrementally.

* Modified from Johnson and McGuinness (1975).

Table 14

Estimated Man-Hours for Various Aspects of Vegetation Establishment

Action	Unit	Man-Hours	Remarks
Collecting seeds	50,000 seeds	6-8	Rate depends on species and training of personnel
Storing seeds	50,000 seeds	2 initially, 0 daily	Requires no maintenance
Planting seeds	50,000 seeds	1-2	Mechanically
		3	Broadcast by hand
		8 plus	Planted in rows by hand
Digging propagules	1,000 propagules	12-16	Rate depends on species, form of propagule, and training of personnel
Storing and handling propagules	1,000 propagules	16-24 initially, 2-4 daily	Requires maintenance
Planting propagules	1,000 propagules	2	Mechanically
		8	Hand labor
Fertilizing	1 hectare	1.5-2	Mechanically
Liming	1 hectare	1.5-2	Mechanically
Cultivating	1 hectare	1.5-2	Mechanically
Mowing	1 hectare	1.5-2	Mechanically
Staking and pruning	1,000 plants	4-8	Hand labor

APPENDIX A: A PARTIAL LISTING OF COMMERCIAL SOIL TESTING FACILITIES

Company	Address
A & L Agricultural Laboratories, Inc.	2176 Dunn Avenue Memphis, TN 38114 (also in Omaha, NE, and Fort Wayne, IN)
Agrico Chemical Co.	See Agrico sales personnel in area served
Agri Consultants Laboratory	Brighton, CO 80801
Agrico Service Laboratory	Box 639 Jamison Road Washington Court House, OH 43160
Alsen's Agricultural Laboratory	McCook, NE 69001
Brookside Research Laboratories	New Knoxville, OH 45871
Dr. Benjamin Wolf Agricultural Laboratories	6861 S.W. 45 Street Ft. Lauderdale, FL 33314
Enviro-Service, Inc.	Scottsbluff, NE 69361
Food Chemicals and Research Laboratories	1201 N.E. 38th Street Seattle, WA 98704
Harris Laboratories	Box 520 Lexington, NE 68850
Holman/Pyle Company	5612 Patterson Little Rock, AR 72209
InterAmerican Laboratory	Cozad, NE 69130
International Agricultural Services	320 Judah Street San Francisco, CA 94122
Iowa Testing Laboratory, Inc.	Eagle Grove, IA 50533
Laucks Testing Laboratories	1008 Wester Avenue Seattle, WA 98104

Company	Address
National Spec. Laboratory	6300 Euclid Avenue Cleveland, OH 44103
Nu-Ag	Box 239 Rochelle, IL 61068
Pattison's Laboratories	Box 346 Harlington, TX 78550
Saint Louis Testing Laboratories	2810 Clark Avenue St. Louis, MO 63103
Servi-Tech Inc.	Dodge City, KS 67801
Soil & Plant Laboratory, Inc.	Santa Ana, CA 92700
Southern Testing & Research Laboratories	Box 350 Wilson, NC 27893
United States Testing Company, Inc.	Cotton Exchange Building Memphis, TN 38103
St. Louis Testing Laboratories, Inc.	2810 Clark Avenue St. Louis, MO 63103
Woodson-Tenent Laboratories	1805 East Fifth North Little Rock, AR 72114

APPENDIX B: COMMON AND SCIENTIFIC NAMES OF ANIMALS AND PLANTS MENTIONED IN THE TEXT AND TABLES

Animals

Common Name	Scientific Name
Canada goose	*Branta canadensis*
Common crow	*Corvus brachyrhynchos*
Common tern	*Sterna hirundo*
Cotton rat	*Sigmodon hispidus*
Deer	*Odocoileus* spp.
Goat (feral)	*Capra hircus*
Herring gull	*Larus argentatus*
Norway rat	*Rattus norvegicus*
Nutria	*Myocastor coypus*
Rabbit	*Sylvilagus* spp.
Ring-billed gull	*Larus delawarensis*

Plants

Alfalfa	*Medicago sativa*
Alsike clover	*Trifolium hybridum*
American beachgrass	*Ammophila breviligulata*
American beech	*Fagus grandiflora*
American bittersweet	*Celastrus scandens*
American dunegrass	*Elymus mollis*
American elderberry	*Sambucus canadensis*
American hornbeam	*Carpinus caroliniana*
American plum	*Prunus americana*
American sycamore	*Platanus occidentalis*
Amur honeysuckle	*Lonicera mackii*
Arrow-leaved tearthumb	*Polygonum sagittatum*
Arrowwood viburnum	*Viburnum dentatum*
Australian pine	*Casuarina equisetifolia*
Autumn olive	*Elaeagnus umbellata*

Common Name	Scientific Name
Bahia grass	Paspalum notatum
Bamboo vine	Smilax laurifolia
Barley	Hordeum vulgare
Barnyard grass	Echinochloa crusgalli
Bayberry	Myrica pensylvanica
Beach morning glory	Ipomoea stolonifera
Beach panic grass	Panicum amarum
Beach pea	Lathyrus japonicus
Beach plum	Prunus maritima
Beach strawberry	Fragaria chiloensis
Beaked panic grass	Panicum anceps
Bearberry	Arctostaphylos uva-ursi
Beautyberry	Callicarpa americana
Bicolor lespedeza	Lespedeza bicolor
Big bluestem	Andropogon gerardi
Big filaree	Erodium botrys
Bird'sfoot trefoil	Lotus corniculatus
Bittersweet nightshade	Solanum dulcamara
Black cherry	Prunus serotina
Black cottonwood	Populus trichocarpa
Black gum	Nyssa sylvatica
Black locust	Robinia pseudoacacia
Black medic	Medicago lupulina
Black nightshade	Solanum nigrum
Black raspberry	Rubus occidentalis
Black walnut	Juglans nigra
Black willow	Salix nigra
Blackseed plantain	Plantago rugeli
Blue brush	Ceanothus thryiflorus
Blue elderberry	Sambucus caerulea
Bottlebrush	Plantago arenaria
Bracted plantain	Plantago aristata
Brazilian peppertree	Schinus terebinthifolius

Common Name	Scientific Name
Brewer saltbush	Atriplex breweri
Broadleaf plantain	Plantago major
Bromegrass	Bromus inermus
Broomsedge	Andropogon virginicus
Browntop millet	Panicum ramosum
Buckthorn plantain	Plantago lanceolata
Buffaloberry	Shepheria canadensis
Bull paspalum	Paspalum boscianum
Bush lupine	Lupinus albifrons
Bush lupine	Lupinus arboreus
Bushy beardgrass	Andropogon glomeratus
Calandrinia	Calandrinia maritima
Calley Bermuda grass	Cynodon dactylon hybrid
California blackberry	Rubus ursinus
California buckthorn	Rhamnus californica
Camphorweed	Heterotheca subaxillaris
Canadian serviceberry	Amelanchier canadensis
Carolina ash	Fraxinus caroliniana
Carolina rose	Rosa carolina
Cascara buckthorn	Rhamnus purshiana
Cherry laurel	Prunus caroliniana
Chickasaw plum	Prunus angustifolia
Chufa	Cyperus esculentus
Coastal Bermuda grass	Cynodon dactylon hybrid
Coast deervetch	Lotus formosissimus
Coastal juneberry	Amelanchier canadensis
Common Bermuda grass	Cynodon dactylon
Common buckthorn	Rhamnus caroliniana
Common chickweed	Stellaria media
Common chokeberry	Prunus virginiana
Common deerberry	Vaccinium stamineum
Common filaree	Erodium cicutarium
Common greenbrier	Smilax rotundifolia

Common Name	Scientific Name
Common juniper	Juniperus communis
Common lambsquarters	Chenopodium album
Common mullein	Verbascum thapsus
Common purslane	Portulaca oleracea
Common ragweed	Ambrosia artemisiifolia
Common reed	Phragmites australis
Common spikerush	Eleocharis palustris
Common sweetleaf	Symplocos tinctoria
Common threesquare	Scirpus americanus
Corn	Zea mays
Cow oak	Quercus michauxii
Cow pea	Vigna sinensis
Crabapple	Malus angustifolia
Crimson clover	Trifolium incarnatum
Crossvine	Bignonia capreolata
Croton	Croton californicus
Curly dock	Rumex crispus
Dallis grass	Paspalum dilatum
Dahoon	Ilex cassine
Deertongue	Muhlenbergia rigens
Deerweed	Lotus scoparius
Dog fennel	Eupatorium capillifolium
Downy serviceberry	Amelanchier arborea
Dwarf spikerush	Eleocharis parvula
Eastern cottonwood	Populus deltoides
Eastern hophornbeam	Ostrya virginiana
Eastern red cedar	Juniperus virginiana
Eastern white pine	Pinus strobus
Elderberry	Sambucus glauca
Elderberry	Sambucus callicarpa
European beachgrass	Ammophila arenaria
Evergreen blackberry	Rubus laciniatus
Fall panic ras	Panicum dichotomiflorum

Common Name	Scientific Name
Filaree	Erodium obtusiplicatum
Firethorn	Pyracantha coccinea
Flat pea	Lathyrus sylvestris
Flowering dogwood	Cornus florida
Flowering spurge	Euphorbia corollata
Fox grape	Vitis labrusca
Foxtail millet	Setaria italica
Fringed catbrier	Smilax bona-nox
Frost grape	Vitis vulpina
Gallberry	Ilex glabra
Giant ragweed	Ambrosia trifida
Goosefoot	Chenpodium murale
Goose grass	Eleusine indica
Gray dogwood	Cornus racemosa
Green ash	Fraxinus pennsylvanica
Green bristlegrass	Setaria viridus
Ground blueberry	Vaccinium myrsinites
Groundsel tree	Baccharis haminifolia
Hackberry	Celtis occidentalis
Halberd-leaved willow	Salix hastata
Hardstem bulrush	Scirpus acutus
Hairy vetch	Vicia hirsuta
Hemp sesbania	Sesbania exaltata
Hibiscus	Hibiscus mascheutos
Highbush blueberry	Vaccinium corymbosum
Hollyleaf cherry	Prunus ilicifolia
Honey locust	Gleditsia triacanthos
Honey mesquite	Prosopis juliflora
Hooker's willow	Salix hookeriana
Hop clover	Trifolium procumbens
Horse nettle	Solanum carolinense
Horseweed	Erigeron canadensis
Italian ryegrass	Lolium multiflorum

Common Name	Scientific Name
Japanese clover	Lespedeza striata
Japanese honeysuckle	Lonicera japonica
Japanese millet	Echinochloa crusgalli hybrid
Japanese lespedeza	Lespedeza japonica
Jerusalem artichoke	Helianthus tuberosus
Johnson grass	Sorghum halepense
Jungle rice	Echinochloa colonum
Korean clover	Lespedeza stipulacea
Kudzu	Pueraria lobata
Ladino clover	Trifolium repens latum
Ladysthumb	Polygonum persicaria
Lanceleaf greenbrier	Smilax smallii
Large crabgrass	Digitaria sanguinalis
Laurel oak	Quercus laurifolia
Lespedeza	Lespedeza striata
Little hairgrass	Aira praecox
Live oak	Quercus virginiana
Loblolly pine	Pinus taeda
Longleaf pine	Pinus palustris
Low blueberry	Vaccinium vacillans
Lupine	Lupinus polyphyllus
Malta starthistle	Centaurea melitensis
Mapleleaf goosefoot	Chenopodium hybridum
Mapleleaf viburnum	Viburnum acerifolium
Marsh elder	Iva frutescens
Marsh pea	Lathyrus palustris
Marsh pepper	Polygonum hydropiper
Maximillian's sunflower	Helianthus maximilliani
Mexican tea	Chenopodium ambrosioides
Mockernut hickory	Carya tomentosa
Mountain blackberry	Rubus allegheniensis
Multiflora rose	Rosa multiflora
Muscadine grape	Vitis rotundifolia

Common Name	Scientific Name
Musk filaree	Erodium moschatum
Myrtle oak	Quercus myrtifolia
Narrowleaf vetch	Vicia angustifolia
Nodding smartweed	Polygonum lapathifolium
Northern bayberry	Myrica pensylvanica
Nutsedge	Cyperus filiculmis
Oats	Avena sativa
Oleander	Nerium oleander
Olney threesquare	Scirpus olneyi
Orache	Atriplex patula
Orchard grass	Dactylis glomerata
Pacific bayberry	Myrica californica
Pacific dogwood	Cornus nuttallii
Pacific wax myrtle	Myrica californica
Pacific willow	Salix lasiandra
Panic grass	Panicum clandestinum
Paper mulberry	Broussonetia papyrifera
Partridge pea	Cassia fasciculata
Peachleaf willow	Salix amygdaloides
Pearl millet	Pennisetum glaucum
Pecan	Carya illinonensis
Pennsylvania smartweed	Polygonum pensylvanicum
Peppervine	Ampelopsis arborea
Perennial ryegrass	Lolium perenne
Persimmon	Diospyros virginiana
Pickleweed	Rumex occidentalis
Pignut hickory	Carya glabra
Poison ivy	Rhus radicans
Pokeberry	Phytolacca americana
Possumhaw	Ilex decidua
Possumhaw viburnum	Viburnum nudum
Prairie cordgrass	Spartina pectinata
Proso millet	Panicum miliaceum

Common Name	Scientific Name
Prostrate knotweed	Polygonum aviculare
Prostrate pigweed	Amaranthus blitoides
Prostrate spurge	Euphorbia supina
Purple nutsedge	Cyperus rotundus
Purple osier willow	Salix purpurea
Purple vetch	Vicia americanus
Pussy willow	Salix discolor
Quackgrass	Agropyron repens
Quail brush	Atriplex lentiformis
Red alder	Alnus rubra
Redbay	Persea borbonia
Red buckeye	Aesculus parvia
Red clover	Trifolium pratense
Red fescue	Festuca rubra
Red maple	Acer rubrum
Red mulberry	Morus rubra
Red osier dogwood	Cornus stolonifera
Redroot pigweed	Amaranthus retroflexus
Redtop	Agrostis alba
Reed canary grass	Phalaris arundinacea
Rescue grass	Bromus catharticus
Reseeding soybean	Glycine ussuriensis
Rice cutgrass	Leersia oryzoides
River birch	Betula nigra
River bulrush	Scirpus fluviatilis
Riverflat hawthorn	Crateagus opaca
Rough-leaved dogwood	Cornus drummondii
Russian olive	Elaeagnus angustifolia
Rusty blackhaw	Viburnum rufidulum
Rye	Secale cereale
Salal	Gautheria shallon
Salmonberry	Rubus spectabilis
Saltbush	Atriplex polycarpa

Common Name	Scientific Name
Saltcedar	*Tamarisk parviflora*
Saltgrass	*Distichlis spicata*
Saltmarsh bulrush	*Scirpus robustus*
Saltmeadow cordgrass	*Spartina patens*
Saltwort	*Salsola kali*
Sandbar willow	*Salix interior*
Sand blackberry	*Rubus cuneifolius*
Sand dropseed	*Sporobolus cryptandrus*
Sand pine	*Pinus clausa*
Sassafras	*Sassafras albidum*
Sawbrier	*Smilax glauca*
Sawtooth oak	*Quercus acutissima*
Schweinitz's nutsedge	*Cyperus schweinitzii*
Scotch broom	*Cytisus scoparius*
Sea blite	*Suaeda maritima*
Sea oats	*Uniola paniculata*
Sea oxeye	*Borrichia frutescens*
Seashore bluegrass	*Poa macantha*
Seashore lupine	*Lupinus littoralis*
Seashore paspalum	*Paspalum vaginatum*
Seaside dock	*Rumex maritima*
Seaside goldenrod	*Solidago sempervirens*
Seaside plantain	*Plantago maritima*
Sericea lespedeza	*Lespedeza cuneata*
Sharp-toothed blackberry	*Rubus argutus*
Sheep sorrel	*Rumex acetosella*
Shining sumac	*Rhus copallina*
Shoredune panic grass	*Panicum amarulum*
Shore pine	*Pinus contorta*
Showy tick-trefoil	*Desmodium candense*
Shrub verbena	*Lantana camara*
Silky dogwood	*Cornus amomum*
Silky willow	*Salix sericea*

Common Name	Scientific Name
Silverleaf croton	Croton punctatus
Sitka alder	Alnus sinuata
Sixweeks fescue	Festuca octoflora
Slash pine	Pinus elliottii
Smooth crabgrass	Digitaria ischaemum
Smooth sumac	Rhus glabra
Sorghum	Sorghum vulgare
Southern bayberry	Myrica cerifera
Southern bulrush	Scirpus californicus
Southern dewberry	Rubus trivialis
Southern ragweed	Ambrosia bidentata
Southern red oak	Quercus falcata
Soybean	Glycine max
Sparkleberry	Vaccinium arboreum
Spotted burclover	Medicago arabica
Spotted spurge	Euphorbia maculata
Squarestem spikerush	Eleocharis quadrangulata
Squaw huckleberry	Vaccinium stamineum
Staghorn sumac	Rhus typhina
Sudan grass	Sorghum sudanese
Sugarberry	Celtis laevigata
Sugar maple	Acer saccharum
Summer grape	Vitis aestivalis
Summersweet	Clethra alnifolia
Sunflower	Heliantus giganteus
Supplejack	Berchemia scandens
Swamp privet	Forestiera acuminata
Swamp rose	Rosa palustris
Sweetbay	Magnolia virginiana
Sweetgum	Liquidambar styraciflua
Switchgrass	Panicum virgatum
Tag alder	Alnus serrulata
Tall fescue	Festuca arundinacea

Common Name	Scientific Name
Tansy mustard	*Descurainia pinnata*
Tatarian honeysuckle	*Lonicera tatarica*
Texas huisache	*Acacia smallii*
Texas millet	*Panicum texanum*
Thorny eleagnus	*Elaeagnus pungens*
Timothy	*Phleum pratense*
Toothache tree	*Zanthoxylum clava-herculis*
Torpedo grass	*Panicum repens*
Tropic croton	*Croton glandulosus*
Tulip poplar	*Liriodendron tulipifera*
Tumbleweed	*Amaranthus albus*
Turkey oak	*Quercus laevis*
Vasey grass	*Paspalum urvillei*
Virginia creeper	*Parthenocissus quinquefolia*
Virginia dropseed	*Sporobolus virginicus*
Virginia pepperweed	*Lepidium virginicum*
Walter's millet	*Echinochloa walterii*
Water oak	*Quercus nigra*
Wax myrtle	*Myrica cerifera*
Western blackberry	*Rubus vitifolia*
Western chokecherry	*Prunus virginiana dimissa*
Western dogwood	*Cornus occidentalis*
Western huckleberry	*Vaccinium ovatum*
Western ragweed	*Ambrosia psilostachya*
Wheat	*Triticum aestivum*
White ash	*Fraxinus americana*
White clover	*Trifolium repens*
White oak	*Quercus alba*
White poplar	*Populus alba*
White sweetclover	*Melilotus alba*
Wild apple	*Malus pumila*
Wild bamboo	*Smilax auriculata*
Wild bean	*Strophostyles helvola*

Common Name	Scientific Name
Wild black currant	*Ribes americanum*
Wild buckwheat	*Polygonum convolvulus*
Wild cherry	*Prunus emarginata*
Wild indigo	*Baptisia leucophaea*
Wild rye	*Elymus virginicus*
Wild rose	*Rosa rugosa*
Wild sensitive pea	*Cassia nictitans*
Wild strawberry	*Fragaria virginiana*
Wingscale	*Atriplex canescens*
Winterberry	*Ilex verticillata*
Witchhazel	*Hammamelis virginiana*
Woolly croton	*Croton capitatus*
Woolly indianwheat	*Plantago purshii*
Woolly panic grass	*Panicum lanuginosum*
Yaupon	*Ilex vomitoria*
Yellow bristlegrass	*Setaria lutescens*
Yellow paloverde	*Centaurea solstitialis*
Yellow starthistle	*Cercidium microphyllum*
Yellow sweetclover	*Melilotus officinalis*

APPENDIX C: SOURCES OF PLANT PROPAGULES

Alabama

Private sources

Bomar Seed Company
2313 7th Street
Tuscaloosa, AL 35401
— legumes, millets, grasses, chufa, sunflowers

Eufaula Milling Company
Eufaula, AL 36027
— chufa, millet, legumes, and grasses

R. E. Lambert & Sons, Inc.
Darlington, AL 36730
— specializes in waterfowl and wildlife food plants and seeds

Sawan Seed Company
1324 Railroad Avenue
Guntersville, AL 35976
— legumes, millet, chufa

J. B. Sylvest Seed Company
129 Coosa
Montgomery, AL 36104
— chufa, millets, legumes, grasses, sunflowers

Alaska

Agency sources

Alaska Plant Materials Center
Star Rt. B
Palmer, AK 95237

Petersburg Pilot Greenhouse
Tongrass National Forest
P. O. Box 309
Petersburg, AK 99333

Arkansas

Agency sources

Ouachita Orchard
U. S. Forest Service
Mt. Ida, AR 71957
— *pine seeds*

Arizona

Agency sources

Tucson Plant Materials Center
3241 Romero Road
Tucson, AZ 85705

California

Private sources

Armstrong Nurseries Box 473 Ontario, CA 91764	wildflowers, grasses
Clyde Robin Seed Company Box 2855H Castro Valley, CA 94546	native plants, wildflowers
Monrovia Nursery Company Box Q Azasa, CA 91702	native plants, wildflowers
Van Ness Water Gardens 2460 North Euclid Avenue Upland, CA 91786	aquatics, seeds, sedges, marsh plants

Agency sources

Forest Hill Orchard Tahoe National Forest Forest Hill, CA 95631	ponderosa and sugar, pine tree seeds
Happy Camp Orchard Klamath National Forest Happy Camp, CA 96039	sugar pine tree seeds
Humboldt Nursery Six Rivers National Forest 710 E Street Eureka, CA 95501	seeds and trees

Lockeford Plant Materials Center
P. O. Box 368
Lockeford, CA 94566

Oak Grove Nursery
U. S. Forest Service
150 S. Los Robles Avenue
Pasadena, CA 91101

Placerville Nursery — seeds and trees
Eldorado National Forest
100 Forni Road
Placerville, CA 95667

Colorado

Agency sources

Environmental Plant Center
P. O. Box 448
Meeker, CO 81641

Mt. Sopris Nursery — trees
White River National Forest
P. O. Box 948
Glenwood Springs, CO 81601

Connecticut

Private sources

Puskas Wildflower Nursery — wildflowers, native plants
Kent Hollow Road
Kent, CT 06757

Delaware

Agency sources

State Tree Nursery
Delaware Forest Service
P. O. Drawer D
Dover, DE 19901

Florida

Agency sources

Brooksville Plant Materials Center
Route 2, Box 242
Brooksville, FL 33512

Georgia

Private sources

Americus Plant Materials Center
P. O. Box 668
Americus, GA 31709

J. E. Brown — lespedezas, grasses, seeds
P. O. Box 8
Monroe, GA 30655

Tidwell Nurseries — native plants
Greenville, FA 30222

Hawaii

Agency sources

Hawaii Plant Materials Center
P. O. Box 236
Hoolehua, HI 96729

Idaho

Agency sources

Aberdeen Plant Materials Center
P. O. Box AA
Aberdeen, ID 83210

Boulder Creek Orchard — ponderosa seeds
Payette National Forest
McCall, ID 83638

Coeur d'Alene Nursery — seeds and trees
U. S. Forest Service
Rt. 1 Box 245
Coeur d'Alene, ID 83814

Lucky Peak Nursery — seeds and trees
Boise National Forest
1075 Park Blvd.
Boise, ID 83706

Illinois

Agency sources

Pleasant Valley Orchard — black walnut seeds
U. S. Forest Service
Jonesboro, IL 62952

Indiana

Private sources

Vallonia Nursery
Vallonia, IN 47281

Iowa

Private sources

The Shenandoah Nurseries — native trees and shrubs
Box 99
Shenandoah, IA 51601

Agency sources

State Forest Nursery
P. O. Box 823
2404 S. Duff Avenue
Ames, IA 50010

Kansas

Private sources

Sharp Bros. Seed Company — native grasses
Healy, KS 67850

Agency sources

Manhattan Plant Materials Center
Rt. 2, Box 314
Manhattan, KS 66502

Kentucky

Agency sources

Quicksand Plant Materials Center
Quicksand, KY 41363

Louisiana

Private sources

Grandview Nursery — native plants
RFD Box 54
Youngsville, LA 70592

Magnolia State Nursery — native plants
8820 Greenwell Springs Road
Baton Rouge, LA 70814

Agency sources

Stuart Project — seeds and trees
U. S. Forest Service
Rt. 2, Box 684
Pollack, LA 71467

Maine

Agency sources

State Forest Nursery
RFD #2
Passadumkeag, ME 04475

Maryland

Private sources

Environmental Concern Inc. — transplants, seeds, grasses, marsh and dune plants, aquatics, native shrubs
St. Michaels, MD 21663

Massachusetts

Private sources

Allgrove — native plants
Box 459H
Wilmington, MA 08117

Michigan

Agency sources

J. W. Toumery Nursery
Ottawa National Forest
P. O. Box 468
Ironwood, MI 49938

Rose Lake Plant Materials Center
Route 1
East Lansing, MI 48823

Minnesota

Agency sources

Eveleth Nursery
Superior National Forest
P. O. Box 338
Duluth, MN 55801

Mississippi

Private sources

Sawan Seed Company — seeds, grasses, cover crops
Columbus, MS 39601

Agency sources

W. W. Ashe Nursery — seeds and trees
U. S. Forest Service
Box 8
Brooklyn, MS 39425

Coffeeville Plant Materials Center
Coffeeville, MS 38922

Missouri

Private sources

Forest Keeling Nursery — native trees, shrubs, other plants
Elsberry, MO 63343

Agency sources

Elsberry Plant Materials Center
P. O. Box 108
Elsberry, MO 63343

Montana

Agency sources

Bridger Plant Materials Center
Route 1, Box 81
Bridger, MT 59014

Nebraska

Agency sources

Bessey Nursery
Nebraska National Forest
270 Pine Street
Chadron, NE 69337

Nevada

Agency sources

State Forest Nursery
201 S. Fall Street
Carson City, NV 89701

New Hampshire

Agency sources

State Forest Nursery
RFD #7
Penacook, NH 03301

New Jersey

Private sources

Woodstream Nursery — native plants
Box 510H
Jackson, NJ 08527

Agency sources

Cape May Plant Materials Center
Route 1, Box 236A
Cape May Courthouse, NJ 08210

New Mexico

Agency sources

Los Lunas Plant Materials Center
1036 Miller Street, S. W.
Los Lunas, NM 87031

New York

Agency sources

Big Flats Plant Materials Center
P. O. Box 295, Rt. 352
Big Flats, NY 14814

North Carolina

Private sources

Beech Creek Orchard
U. S. Forest Service
201 Woodland Drive
Murphy, NC 28906

pines and oaks

Land of the Sky Nurseries
108 Lakewood Drive
Asheville, NC 28803

native plants

North Dakota

Agency sources

Bismarck Plant Materials
Lincoln-Oakes Nursery
P. O. Box 1458
Bismarck, ND 58501

Ohio

Private sources

William Tricker Inc.
14 Tanglewood Drive
Independence, OH 44131

marsh and aquatic plants, native plants

Oklahoma

Private sources

Weyerhaeuser Co.
Rt. 1, Box 10-A
Ft. Towson, OK 47435

Oregon

Private sources

Wave Beach Grass Nurseries, Inc.
P. O. Box 457
Florence, OR 97439

transplants, seeds, grasses, sedges, marsh and dune plants

Crown Zellerback Wood Nursery
P. O. Box 509, Rt. 2
Aurora, OR 97002

Georgia-Pacific Nursery
R&D Center
P. O. Box 1618
Eugene, OR 97401

Weyerhaeuser Nursery
P. O. Box 235
Aurora, OR 97002

Agency sources

Beaver Creek Nursery — seeds and trees
Suislaw National Forest
P. O. Box 1148
Corvallis, OR 97330

Bend Nursery
Deschutes National Forest
211 NE Revere Avenue
Bend, OR 97701

Corvallis Plant Materials Center
3240 NE Granger Avenue
Corvallis, OR 97330

Pennsylvania

Private sources

Flinkingers' Nursery — native plants, wildflowers
Box 6
Sagamore, PA 16250

Nelson Tree Nursery — native trees and shrubs
DuBois, PA 15801

Agency sources

Blue Jay Orchard — cherry tree seeds
U. S. Forest Service
Marienville, PA 16239

Rhode Island

NONE (Consult lists of adjacent states)

South Carolina

Agency sources

Coastal Nursery
P. O. Box 786
St. George, SC 29477

Ridge Nursery
P. O. Box 216
Trenton, SC 29847

Tilghman Nursery
P. O. Box 425
Wedgefield, SC 29179

South Dakota

Agency sources

Big Sioux Conifer Nursery
Rt. 2
Watertown, SD 57201

Tennessee

Private sources

Warren County Nursery Inc. — wildlife cover and native plants
Rt. 2, Box 153
McMinnville, TN 37110

Agency sources

Unaka Orchard — oak tree acorns
Cherokee National Forest
Erwin, TN 37650

Watauga Orchard — oak tree acorns
Cherokee National Forest
P. O. Box 431
Elizabethton, TN 37643

Texas

Private sources

Ghost Town Cactus Company — desert and high plains native plants
Rt. 3, Box 346
Midland, TX 79701

Jonak Nursery — native plants, wildflowers
Rt. 1, Box 174
Shiner, TX 77984

Woodruff Terratex Corporation — grasses, seeds
318 Cadiz Suite 260-262
Dallas, TX 75207

Wolfe Nursery — wildflowers, native plants
500 Terminal Road
Fort Worth, TX 76106

Agency sources

Knox City Plant Materials Center
Route 1, Box 155
Knox City, TX 79529

Utah

Agency sources

State Forest Nursery
1594 W. North Temple
Salt Lake City, UT 84116

Vermont

Agency sources

State Tree Nursery
Essex Junction, VT 05452

Virginia

Private sources

Continental Can Co. Pine Tree Nursery
P. O. Box 1041
Hopewell, VA 23860

Agency sources

Augusta Forestry Center
P. O. Box 9028
Crimora, VA 24431

New Kent Forestry Center
P. O. Box 305
Providence Forge, VA 23140

Washington

Agency sources

Dennie Ahl Orchard
U. S. Forest Service
P. O. Box 520
Shelton, WA 98584

Douglas fir seeds

Pullman Plant Materials Center
Room 257, Johnson Hall
Washington State University
Pullman, WA 99163

Wind River Nursery
Gifford Pinchot National Forest
500 W. 12th Street
Vancouver, WA 98660

West Virginia

Agency sources

Bishop Knob Orchard
U. S. Forest Service
Richwood, WV 26261

black cherry tree seeds

Wisconsin

Private sources

Game Food Nurseries
P. O. Box 2371
Oshkosh, WI 54901

specializes in waterfowl and wildlife food plants and seeds

Wildlife Nurseries
P. O. Box 399
Oshkosh, WI 54901

specializes in waterfowl and wildlife food plants and seeds

Wyoming

NONE (Consult lists of adjacent states)

There are numerous state and private sources of native tree seeds and seedlings listed in U. S. Forest Service reports:

Forest Tree Seed Orchards, October 1974.

Forest Tree Nurseries, July 1976.

These reports are unnumbered, miscellaneous, limited distribution documents which may be obtained by writing Chief, Forest Service, U. S. Department of Agriculture, Washington, D. C. 20250.

Other Agency Sources

State Agricultural Experiment Station (at Land Grant Colleges in each state).

State Forests (have numerous small nurseries).

State Departments of Natural Resources, Game and Fish Commissions, or Departments of Agriculture (sources of information only).

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In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Hunt, L Jean
Upland habitat development with dredged material engineering and plant propagation / [by L. Jean Hunt ... et al.] Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
84, [76] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; DS-78-17)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C.
References: p. 73-84.

1. Dredged material disposal. 2. Habitat development. 3. Habitats. 4. Plants (Botany). 5. Vegetation. 6. Waste disposal sites. 7. Wildlife management. I. United States. Army. Corps of Engineers. II. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; DS-78-17.
TA7.W34 no.DS-78-17